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Productivity

There is now in the United Kingdom a special mission from the Economic Co-operation Administration, the United States organisation which administers Marshall Aid. A few days after the arrival of the mission, the Chancellor of the Exchequer announced the devaluation of the £ sterling. To-day, there has been published the Report of the British Steel Founders' productivity team which visited the United States in March and April this year. These three apparently unconnected occurrences are bound together in the emphasis they lay upon the need for increasing our sales of goods in the dollar area by means of the competitiveness which can be attained by high productivity. True, competitiveness may be attained by the reduction of the standard of living, but that is a poor alternative.

At our request, Mr. F. A. Martin, O.B.E., President of the British Steel Founders' Association, has very courteously accepted our invitation to write the accompanying leading article.

The Report, besides making a case for high productivity and stating quite bluntly that the productivity of American steelfounders is from 50 to 90 per cent. greater on the average than that of our own, gives importance of place to the mental outlook which must be developed in order to achieve a high level of productivity in this country and, in passing, lets out several side kicks at restrictive practices and the wastefulness of some of our established customs. Much of the matter has a wider reference than to the steelfounding industry. This was to be expected in the report of the first team to tackle the job of finding out "how the Americans do it," and reporting back to Britain. Large sections are clearly intended to be read, not only by foundrymen, but by industrialists and trade unionists in a wider circle of industry. The more general observations are segregated from the particularised parts and are almost free from technical allusion to steelfounding processes. The intention of the Report is to stimulate thought. It "marks the stage at which the steelfounders of Britain all become partners in this venture." They are invited to "give to it, in study and constructive criticism, as much as they wish to gain."

There is plenty to discuss in the 100-and-odd pages of the Report. As well as factual observations, views are expressed, sometimes in provocative manner. Out of free and unprejudiced discussion of these views some good can come.

Many of the facts reported are what might have been expected—insistence upon quantity-production runs in the United States steelfoundries, more standardisation, greater power per man and far more effective handling of materials. All these we have been told about, and the story is repeated in the Report with special reference to steelfounding. What is to be done with this material? Only if it is well used can the visit of the first productivity team be pronounced a success. Hard on the heels of the publication of the Report comes word that the British Steel Founders' Association propose to organise in the near future a technical convention to discuss the productivity team report This should make a good start to the work of disseminating the views brought over from the other side. Members of the team hold themselves in readiness to attend local meetings of the various organisations interested, and in this way still more can be achieved. The most earnest hope of the members of the team is that within a year the Report may be completely out of date.

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Forthcoming Events

(Secretaries are invited to send notices of meetings for inclusion in this column)

SEPTEMBER 30.

Institute of British Foundrymen.

Lincoln Branch:—Visit to Harrison & Company (Lincoln), Hykeham; Presidential address.

Falkirk Section:—"Production of Grey-iron Castings," by C. R. van der Ben and H. Haynes, at the Temperance Café, Lint Riggs, Falkirk, at 7 p.m.

Royal Statistical Society.

Industrial Applications Section, Birmingham Group:—"Statistics as an Aid to Productivity," by J. Rodgers, at the Chamber of Commerce, 95, New Street, Birmingham, at 6.30 p.m.

OCTOBER 1.

Institute of British Foundrymen.

Lincoln Branch:—Visit to Harrison & Company (Lincoln), Hykeham; Presidential address.

OCTOBER 3.

Institute of British Foundrymen.

Sheffield Branch:—Presidential address, at the Royal Victoria Station Hotel, Sheffield, at 7.30 p.m.

Institution of Production Engineers.

Yorkshire Section:—"Adaptability of the Jig Bore Machine for Use as a Production Machine," by V. J. Sayers, at the Hotel Metropole, King Street, Leeds, at 7 p.m.

OCTOBER 4.

Association of Bronze and Brass Founders.

Lancashire and Cheshire Area:—Informal meeting, at the Midland Hotel, Manchester, at 12.30 p.m.

Institute of British Foundrymen.

Burnley Section:—"Centrifugal Castings," by L. Wharton, at Accrington Grammar School, Blackburn Road, Accrington, at 7.30 p.m.

Institution of Production Engineers.

Dundee Section:—Inaugural meeting, at the Mathers Hotel, Whitehall Crescent, Dundee, at 7.45 p.m.

OCTOBER 5.

Institution of Production Engineers.

Preston Section:—"Mechanical Handling," by F. T. Dean, at Clayton, Goodfellow, Limited, Park Road, Blackburn, at 7.15 p.m.

OCTOBER 6.

Institute of Vitreous Enamellers.

Annual Conference, at the Midland Hotel, Birmingham (three days).

OCTOBER 7.

Manchester Association of Engineers.

Presidential address: smoking concert, at the Engineers' Club, Albert Square, Manchester, at 6.45 p.m.

Prominent Foundrymen Honoured

On last Monday night, three prominent foundrymen became Freemen of the City of London by being sworn into the Freedom and Livery of the Founders' Company. They were, Mr. V. C. Faulkner, a past-President and honorary member of the Institute of British Foundrymen, and the Editor of the FOUNDRY TRADE JOURNAL; Col. R. C. Scott, M.C., a director of Kirk & Company (Tubes), Limited, Rotherhithe, and Samuel Russell & Company, Limited, Walsall; and Mr. R. B. Templeton, M.I.Mech.E., past-President of the Institute of British Foundrymen, and managing director of Qualcast (Ealing Park), Limited.

Load Spreading in the South-East

Sir John Buchanan, chairman of the London and South-Eastern Regional Board for Industry, announced last week that the Board's electricity load spreading requirements for the coming winter are to be much less burdensome than they were during the last. "They are based on the assumption that this winter will be as mild as last year," he said. This winter during October no set reduction is called for, but it is emphasised that the utmost economy must be practised if load-shedding is to be avoided.

In November a 10 per cent. reduction must be made from 4-5.30 p.m. In December and January a 20 per cent. reduction is necessary from 8-10 a.m., 10 per cent. from 10-12 noon, leaving the period from 12 noon to 4 p.m. free of load-spreading. Another 20 per cent. is required from 4-5.30 p.m. Thus load-spreading operates daily in December and January for 5½ hours only, as against 12 hours last winter. During February reductions are called for from 8-10 a.m. of 20 per cent. and from 10-12 noon of 10 per cent.

Obituary

MR. ROBERT MCNAUGHTON, late of Bertrams, Limited, general engineers and ironfounders, of Edinburgh, died last week at the age of 80.

MR. FREDERICK P. D. GASPAR, who died on September 16, was a director of Hoare & Company (Engineers), Limited, Old Broad Street, London, E.C.2.

MR. R. G. PALMER, who has died at the age of 66, was managing director of the Eagle Engineering Company, Limited, Warwick. He had been associated with the company for 50 years.

MR. WILLIAM FORBES, who died on September 16, was chairman of the Victaulic Company, Limited, manufacturers of pipe joints and fittings, etc., of Park Lane, London, W.1. He was also a director of the Scottish Tube Company, Limited, and Stewarts and Lloyds, Limited.

News in Brief

COCHRANES (MIDDLESBROUGH) FOUNDRY, LIMITED, is reconstructing its slag wharf at Ormesby Ironworks, Middlesbrough.

THE MOND NICKEL COMPANY, LIMITED, states that its prices for nickel are now, in the U.K.: £321 10s. per ton, delivered works; on the Continent: £325 per ton, c.i.f. Continental port.

BECAUSE OF THE paramount importance of dollar exports, the organisers of the British Industries Fair have decided to increase the circulation of both London and Birmingham sections of the 1950 B.I.F. Catalogue and to divert extra supplies to North American markets. Distribution of the advance edition will take place a month earlier than in previous years, and first consignments will be flown overseas at the end of January. Bulk distribution will take place in February so that overseas trade buyers will be able to plan their tour of the B.I.F. in advance of departure for this country.

Gases in Cast Iron*

Notes on the Hot-extraction Method of Gas Analysis as Applied to Cast Iron

By J. E. Hurst, D.Met., F.I.M. and R. V. Riley, Ph.D., B.Sc.

Introduction

A programme of general study concerning the nature and mode of occurrence of gases in cast iron has formed an important part of the research work carried on in the Author's laboratories during recent years.[1] The major part of this work has been based upon the results obtained with cast-iron samples treated by the vacuum-fusion method of analysis. In this method of gas analysis the elements hydrogen, oxygen and nitrogen present in the iron at the time of sampling are extracted from the molten sample in vacuo and are actually analysed as carbon monoxide, hydrogen and nitrogen gases. During the process, the molten iron in the graphite crucible yields a gas mixture which almost certainly differs in molecular quality from the form in which these elements, oxygen. hydrogen and nitrogen, exist in the solid iron.

It was considered that if the gases could be extracted from cast iron at a lower temperature and in a manner which avoided contact with a hot carbon crucible, more exact information might be obtained upon the nature of the gases present in the solid sample. For this reason the study was recently extended to deal with the subject of evolution of gas from a solid cast-iron specimen upon heating *in vacuo*. It was expected that the hot-extraction methods, used so successfully for the determination of hydrogen in steel would serve as a starting point for this investigation.[2] This method of investigation has proved to be more complicated than was originally planned and the programme of work is far from being completed. It is considered of interest, in view of the results, to record the progress of this work and the results so far obtained.

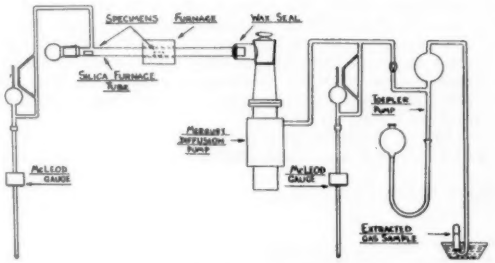

FIG. 1.—DIAGRAM OF THE HOT-EXTRACTION APPARATUS.

The Hot-extraction Method

The existing vacuum-fusion apparatus was modified for the purpose of hot extraction by inserting in place of the high-frequency furnace assembly a length of clear silica tubing 24 in. long by 1¼ in. dia. mounted horizontally (Fig. 1). This tube was connected to the mercury-vapour pump and the free end was sealed by a removable conical cap. A small tubular electric resistance furnace was used for heating purposes. The solid specimen of iron was introduced into the tube from the cap end and was brought into the hot zone by means of a magnet. The whole apparatus was out-gassed at 900 deg. C. prior to an experiment.

The blank value when the apparatus was fully out-gassed was less than 0.01 ml. per hr., which is under 1 per cent. of the total gas sample normally obtained. Experiments were continued for 1 to 2 hours, which was sufficient to remove all the gas which could be extracted at a given temperature.

This hot-extraction apparatus does not take into account any water vapour which might be evolved from the specimens. Water vapour was not noticeable in any of the experiments in which correctly prepared specimens were treated in a fully out-gassed furnace tube. With tarnished specimens, however, some traces of water vapour have been detected.† At the time these experiments were carried out, the laboratory did not possess facilities for estimating water vapour, if evolved during the rocess. Another Vacuum-heating apparatus has since been erected in which is incorporated a furnace tube containing heated ferro-manganese of a type described by G. E. Speight and R. M. Cook.[3] With this equipment any water vapour evolved is decomposed to give free hydrogen which is then estimated along with the hydrogen produced directly from the specimen. The initial experiments with this apparatus have shown that properly prepared specimens free from tarnish or oxide film do not yield water vapour upon heating in vacuo. These initial experiments were carried out using grey phosphoric cast-iron specimens only. It is considered unlikely that the results given in this Paper are invalidated by the failure of the earlier equipment to record moisture.

Gases Obtained from Cast Iron on Hot Extraction

In all the gas samples extracted during the vacuum heating of specimens of cast iron, hydrogen has

* Presented at the Cheltenham Conference of the Institute of British Foundrymen. Dr. Hurst is a past-President of the Institute.

† Cast-iron specimens for hot extraction were machined cylinders ¼ to 1 in. diameter by 1 to 1½ in. long, finally ground by hand on Grade O.O. metallographic polishing emery paper. Immediately upon the completion of grinding the specimen was stored in a vacuum desiccator or in the apparatus under a vacuum.

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proved to be the major constituent. Substantial amounts of carbon monoxide and nitrogen were, however, always present, and the combined volume of these gases often equalled and sometimes exceeded the volume of hydrogen. Typical analyses of the gases extracted from phosphoric grey irons are included in Table I.

From a study of the literature on the composition of the gas sample extracted from steel by similar methods, it would appear that in these experiments with cast iron the percentage of gases other than hydrogen was somewhat larger. Carbon dioxide was present in a few gas samples but only to the extent of 1 or 2 per cent.

TABLE I.—*Composition of Gas Sample Extracted from Grey Phosphoric Iron at 800 deg. C.**

Sample No.	Total evolved, mls. per 100 gm.	Percentage composition of gas.			
		CO_2	CO.	H_2.	N_2.
1	3.2	Nil	38.2	58.2	3.6
2	3.1	—	49.0	40.0	11.0
3	2.0	—	33.4	37.6	29.0
4	2.6	—	30.0	50.5	19.5
5	2.1	—	28.7	60.0	11.3

* *Composition of Iron Used*:—T.C, 3.30; Si, 2.56; Mn, 0.62; S, 0.085; and P, 1.12 per cent.

The substantial amounts of nitrogen and carbon monoxide may be due in part to surface absorbed films or to the influence of graphite flakes in the iron. This is considered in more detail later in the Paper. Chill-cast white irons, free from graphite, gave a gas which was 70 to 90 per cent. hydrogen, whereas phosphoric grey irons yielded only 40 to 70 per cent. hydrogen.

It is of interest to compare the Authors' results with those quoted by G. Hailstone[4] who carried out an investigation into the nature of the gases evolved from cast iron in 1916. From a grey phosphoric iron of similar composition to the irons used in the Authors' investigation, Hailstone extracted a gas having the typical composition: CO_2 2; CO 23, and $H_2 + N$ 75 per cent. The quantity of gas obtained by Hailstone after a 12-hr. heating period at 950 deg. C. was some ten times larger than the average yield in the present experiments at 800 deg. C. It is not possible to work at 950 deg. C. with the apparatus described in this Paper, owing to the risk of reducing the SiO_2 of the silica furnace tube in contact with the iron specimen. Carbon monoxide produced in this way would, of course, be counted along with the gas actually evolved from the specimen.

There appears to be little doubt that substantial amounts of carbon monoxide and nitrogen are evolved along with hydrogen during the vacuum heating of specimens of cast iron in the hot-extraction apparatus at 600 to 800 deg. C. Reeve[5] has shown that oxides of iron, manganese and silica are not reduced by carbon at temperatures less than 1,000 deg. C., therefore it is unlikely that the carbon monoxide which is extracted by vacuum heating at 600 to 800 deg. C. is formed in this way. In the presence of hydrogen, however, which can reduce iron oxide or manganese oxide in this temperature range, the oxygen may possibly be transferred *via* the water-gas reaction to give carbon monoxide,

i.e., $FeO \rightarrow H_2O \rightarrow CO$.

Alternatively the carbon monoxide may be evolved, as such, from the solid iron or from the graphite in the iron. Some further light will be thrown upon the source of the carbon monoxide later in this Paper, but the whole subject is ripe for further study.

Value of the Hot-extraction Method for the Determination of Hydrogen in Cast Iron

Experiments with a hot-extraction apparatus used in other laboratories have shown that, for steel, a hot-extraction temperature of 600 to 800 deg. C. is sufficient to ensure the removal of all the hydrogen from the specimen in 1 to 2 hrs. The early experiments made in this laboratory were concerned with the checking of the validity of this assumption applied to cast iron as distinct from steel. The few initial experiments using cast-iron specimens, summarised in Table I, appeared to give on hot extraction a quantity of hydrogen which was only a small proportion of the total obtainable from the specimens by vacuum fusion. This result was surprising on the basis of steel experience and was therefore investigated further. Experiments were made on specimens all cut from 2 in. dia. test-bars poured at the same time, having a composition as shown in Table II.

In the duplicate tests described earlier, the majority of the gas was evolved during the first 30 mins. The

TABLE II.—*Results of Gas Analysis on Vacuum-heated Samples.**

Temp., deg. C.	Time of heating.	Hydrogen.		Oxygen.		Nitrogen.	
		Mls. per 100 gm.	Parts per million.	Per cent.	Parts per million.	Per cent.	Parts per million
500	2 hrs.	0.51	0.4	0.0003	3.0	0.0004	4.0
,,	,,	0.38	0.3	0.0002	2.0	0.0004	4.0
600	2 hrs.	0.70	0.6	0.0003	3.0	0.0003	3.0
,,	,,	0.75	0.7	0.0004	4.0	0.0004	4.0
800	1½ hrs.	1.70	1.5	0.0010	10.0	0.0002	2.0
,,	,,	1.83	1.6	0.0014	14.0	0.0001	1.0

* Composition of samples:—T.C, 3.30; Si, 2.56; Mn, 0.62; S, 0.85; and P, 1.12 per cent.

TABLE III.—*Results of Vacuum-fusion Analysis on a Sample from the Standard Bar.*

Treatment.	Hydrogen.		Oxygen.		Nitrogen.	
	Mls. per 100 gm.	Parts per million.	Per cent.	Parts per million.	Per cent.	Parts per million.
Vacuum fusion at 1,600 deg. C. ..	4.68	4.5	0.0096	96.0	0.0089	89.0

experiments were in every case continued until all the gas had been collected and until no more was being evolved. The gas recorded as oxygen in Table II was, of course, carbon monoxide in the actual sample analysed; it is expressed as oxygen for convenience in comparing these results with those from vacuum-fusion experiments. There was a slight trace of carbon dioxide in some of the gas samples, but this was in general too small to be regarded as having been positively identified. A specimen was cut from the same bar for vacuum-fusion analysis, with the results shown in Table III.

In order to confirm the results quoted in Table II a further experiment was made using a single specimen in the hot-extraction apparatus, which was then heated first at 600 deg. C., then at 800 deg. C. It was hoped to continue the experiment to 900 deg. C., but unfortunately the furnace winding burnt out before the rate of gas evolution at this temperature had fallen to the blank value. At each increment of temperature the apparatus was pumped by the mercury-vapour pump until no further gas came off. The results given in Table IV show quite clearly that the gas evolved upon heating the cast-iron specimen was dependent upon the temperature of heating.

The specimen used in above experiment was removed from the hot-extraction apparatus and machined from ¼ to ⅜ in. diameter. It was then hand ground to Grade 00. emery paper, cleaned in ether and put back into the vacuum apparatus. The whole operation took only 20 minutes. The specimen was again subjected to vacuum heating at 800 deg. C. and yielded a further quantity of gas (Table V). The same specimen was subsequently analysed for total gas by the vacuum-fusion technique with the result recorded also in Table V.

The second vacuum-heating experiment, with the small specimen, produced a quantity of hydrogen as great as in the first series of experiments using the large-diameter specimen; whilst still more hydrogen was released when this same specimen was melted *in vacuo*.

These experimental results are interpreted as indicating that the rate of diffusion of hydrogen in cast iron is relatively slow—much slower than in ferritic steels. It is understood that certain austenitic steels with high nickel and chromium content show slow diffusion rates and that silicon is also thought to prevent diffusion.[3,4]

Grey cast iron seems to retain its hydrogen much more firmly than could be explained solely on the

TABLE IV.—*Hot-extraction of Gases from Identical Specimen of Cast Iron Successively Heated at Varying Temperatures.*

Temp., deg. C.	Time of heating in hours.	Gases obtained.					
		Hydrogen.		Oxygen.		Nitrogen.	
		Mls. per 100 gm.	Parts per million.	Per cent.	Parts per million.	Per cent.	Parts per million.
600	2½	0.68	0.6	0.0003	3.0	0.0002	2.0
800	2	0.53	0.5	0.0002	2.0	0.0003	3.0
900*	½	0.5 total gas	0.4 total gas				

* Heating failure after ½ hr. at 900 deg. C. Gas sample not analysed.

TABLE V.—*Repeat Tests on Samples after Reduction in Size.*

Condition of specimen.	Gases obtained.					
	Hydrogen.		Oxygen.		Nitrogen.	
	Mls. per 100 gm.	Parts per million.	Per cent.	Parts per million.	Per cent.	Parts per million.
Same specimen as in previous experiment, but machined to ¼ in. dia. Hot-extraction at 800 deg. C.	1.54	1.4	0.0022	22.0	0.0018	18.0
Same specimen as above analysed by vacuum fusion at 1,500 deg. C.	2.00	1.8	0.0014	14.0	0.0027	27.0

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grounds of a slower rate of diffusion in the iron matrix. There are strong reasons to believe that the graphite in iron is a very important constituent in causing the retention of hydrogen. White cast iron shows some tendency to behave like steel and to release its hydrogen more completely upon vacuum heating at 600 to 800 deg. C. This has not been proved conclusively in the work described here. It will be recognised that a difficulty occurs, because at these temperatures most white irons undergo an annealing process which results in a partial or complete breakdown of the carbide into graphite.

Effect of Specimen Surface on Gas Evolved on Hot-extraction

It was found during the early experiments on the vacuum heating of cast iron that specimens which had been left exposed to the atmosphere for some days gave greater amounts of gas on heating than specimens treated immediately after polishing. It was not necessary for the specimen to show any visible surface tarnish to give a difference in the quantity and quality of the gases evolved on vacuum heating. When, however, a slightly rusty specimen was vacuum-heated, the gas evolved was considerably larger than normal. The influence of surface quality is shown in Table VI.

The effect of surface upon the gases extracted on vacuum heating was examined further by adopting specimens having different surface areas all cut from the same sample bar of phosphoric grey iron. Both types of specimens had a ground finish and were left exposed to the air in the laboratory for six hours and were stored until required for testing in an ordinary dessicator. (Average time 3 days.)

Table VII shows that the specimens having the larger surface area evolved a larger volume of nitrogen than the smaller specimens. The hydrogen extracted from the former specimens was also somewhat greater.

Discussion of Results

The investigatory work described in this Paper makes it self-evident that the mechanism governing the evolution of hydrogen from cast iron upon vacuum heating is far from simple.

The hot-extraction technique, which in the case of steels is recognised as giving accurate results for the estimation of total hydrogen, does not apparently work so precisely with cast iron. The composition of the gas evolved at 600 to 800 deg. C. *in vacuo* is not predominantly hydrogen; it contains appreciable amounts of nitrogen and carbon monoxide. Furthermore, the treatment of cast iron in this temperature range does not secure the complete removal of all the hydrogen present in the specimen. Further amounts

TABLE VI.—*Influence of Surface Quality on Gas Evolved on Hot-extraction.*

Condition of specimen.	Time and temperatures.	Gases extracted.					
		Hydrogen.		Oxygen.		Nitrogen.	
		Mls. per 100 gm.	Parts per million.	Per cent.	Parts per million.	Per cent.	Parts per million.
Well polished and treated immediately after polishing	2 hrs. at 800 deg. C.	0.74	0.7	0.0012	12.0	0.0001	1.0
Normally polished specimen. Tested after two days in desiccator	1½ hrs. at 800 deg. C.	1.70	1.5	0.0010	10.0	0.0002	2.0
*Slightly rusty specimen. Tested after two days in laboratory air	1½ hrs. at 800 deg. C.	3.28	3.0	0.0029	29.0	0.0120	120.0

* Water vapour was evolved from this specimen upon hot-extraction. • Composition of the specimens :—T.C, 3.4; Si, 2.4; Mn. 0.70; S, 0.1 and P, 1.2 per cent.

TABLE VII.—*Influence of Surface Area upon Gas Evolved on Hot-extraction at 800 deg. C.*

	Hydrogen.		Oxygen.		Nitrogen.	
	Mls. per 100 gm.	Parts per million.	Per cent.	Parts per million.	Per cent.	Parts per million.
Small surface area	1.4	1.3	0.0002	2.0	0.0019	19.0
	1.3	1.2	0.0001	1.0	0.0018	18.0
	1.5	1.4	0.0002	2.0	0.0018	18.0
Large surface area	1.9	1.7	0.0005	5.0	0.0060	60.0
	1.9	1.7	0.0001	1.0	0.0060	60.0
	2.0	1.8	0.0002	2.0	0.0070	70.0

All samples had the same weight, *i.e.*, 50 gm.; with the small-surface-area specimen, the cylinder area was 3 sq. in.; and with the large-surface-area specimen (three concentric cylinders), the combined area was 9 sq. in.; hot extraction was carried out at 800 deg. C. for 2 hours.

of hydrogen (and carbon monoxide and nitrogen) are obtained on:—(*a*) Raising the extraction temperatures; (*b*) machining off the outer layers of the specimen; (*c*) allowing the specimen to be exposed to the atmosphere; and (*d*) melting the iron.

As a broad conclusion, based upon all the investigatory work carried out by the Authors in connection with the subject of gases in cast iron, they would draw attention to the strong possibility that the total oxygen content, as found by vacuum-fusion analysis of grey cast iron, is not a measure of the inclusions of oxides, silicates, etc., present. The oxygen content is due in part, at least, to the presence of carbon monoxide existing either in voids in the iron or in close association with the flake graphite. Therefore values reported for the oxygen content of cast iron may have an entirely different significance from those resulting from the gas analysis of steel.

The distribution of nitrogen in iron is probably also complicated by the presence of graphite and a more open structure than is found with a wrought metal such as steel.

The more complex metallurgical character of cast iron, as compared with steel, almost certainly accounts for the experiences recorded in this Paper. It is clear that much more work of a fundamental character is required to enable an explanation to be advanced for the behaviour of cast iron in respect of its gas content. This work could with advantage take the form of investigations into:— (1) The rate of diffusion of the gases in cast iron at various temperatures; (2) the extent of the gases' solubility in the graphite of grey cast iron; and (3) the influence of voids and shrinkage cavities upon the retention of gases in iron.

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DISCUSSION

MR. H. J. YOUNG, opening the discussion, said that a Paper read by him in 1923 described the graphite flakes seen under the microscope as *voids partly filled with graphite* and, also, said that an all-pearlitic cupola-melted cast iron containing 3.5 per cent. of total carbon showed no greater amount of graphite flakes under the microscope than did a certain air-furnace-melted cast iron containing only 2.5 per cent. of total carbon. In other words, one of those irons contained, by analysis, 1 per cent. more free graphite than the other, but, under the microscope, appeared to contain a similar amount. It had been suggested that this was due to methods of polishing, but he believed it was caused by the graphite voids being occupied by more gas in the case of the air-furnace iron than that of the cupola-melted one. Moreover, Logan at a later date read a Paper proving that more graphite was often depicted in micrographs of cast irons than could be accounted for by their analytical compositions. These happenings caused him to think that graphite effects—including those of inoculation and nodulation—arose in some degree from gaseous causes and that more of the gases remained within the solid metal than was yet known. It had recently come to his notice that certain specimens, successfully treated with cerium, possessed a pungent hydrocarbon smell when fractured, while other specimens, also treated with cerium, but where nodulation had for some reason or other been unsuccessful, had no smell.

This research should not be permitted to stop because it appeared to be academic. It was of the highest practical importance. It should not be put aside in favour of something easier. Instead, he urged that the easier things be done by individuals and the harder ones by the mass action, financial and otherwise, of bodies such as the Institute. He congratulated the Authors upon pursuing something thoroughly worth while though not spectacular, and certainly not easy.

DR. RILEY, answering these comments, said he thought voids were associated with graphite, but their view depended largely on whether they were skilled in the art of polishing cast iron or not. Friends from the B.C.I.R.A. might perhaps allow that there could be some voids, together with graphite flakes, but he knew graphite sometimes filled holes if they polished an iron very well.

With regard to the retention of gas, the phenomenon of smell from iron fractures was quite common. Not only cerium gave rise to that smell; the addition of calcium silicide also did, and they had even been asked if they could determine what those gases were. Although one might think they were capable of dealing with very small amounts of gas—0.5 parts per million—it was a very difficult matter indeed to analyse a gas sample for that amount of aromatic gas. From smell, perfumes could be detected over a very wide area indeed, but if one tried to estimate the quantity present in the atmosphere, he thought it would be almost impossible. He thought it possible that those gases which smelled were not actually present until they fractured a specimen, and then it might be that the carbides were acted upon by the moisture in the air and the gases were generated. That was one view which might be taken.

Gases in Nodular

MR. FLEMING asked if any gas analysis on nodular iron had been made, and if any significant difference had been found in the behaviour in regard to the retention of gases, particularly hydrogen, as between flake graphite and spherulitic graphite.

DR. RILEY replied they had not dealt with nodular iron. He was interested to hear a question concerning that gas, because in some directions with cerium he

Gases in Cast Iron

had suspected that on the first treatment there was a tendency to retain a high hydrogen content and that, on re-melting irons which had been cerium treated, one might encounter difficulties due to the retention of that hydrogen. He would like to return the question and ask whether Mr. Fleming had had any experience.

MR. FLEMING replied that he had no means of performing gas estimations and that his question was based on a theoretical speculation.

A MEMBER said the possible retention of gas and the liberation of it from graphite had a number of practical aspects. He had come across an example in an American Paper where they had been using ferro-silicon in conjunction with aluminium as a graphitiser. They did encounter gas inclusions, but no definite explanation was put forward.

Hydrogen Content of Graphitisers

DR. RILEY doubted whether he could answer that question very effectively. One had to remember that most of the graphitisers—he referred to ferro-silicon or powdered graphite or the like—were usually found to be very rich in hydrogen itself, and therefore it might be due to the contribution made by the addition that they did increase the hydrogen content of the melt. He suggested that with an aluminium addition one presumably absorbed some of the oxygen, and he imagined that this might upset the balance between hydrogen and oxygen, and perhaps hydrogen would be evolved under such circumstances. That was pure conjecture. He had made no experiments in order to check that view.

MR. JOHN HIRD said, with reference to the last speaker's question, he remembered many years ago there had been a case where aluminium was added to the melt for a special job. The castings came out well, but the back scrap went through the cupola again and there was a terrific epidemic of small blow-holes in castings made with the iron that contained the back-scrap containing aluminium. It looked as though it had some adverse effect on the gas content of the iron.

With regard to Dr. Riley's assumption that the extra gas evolved from the cast iron was due to the graphite, had he tried white iron, and how did it behave?

The Case of White Iron

DR. RILEY agreed, and in connection with the second part of the question he referred to page 3 of the Preprint, where there was a reference to white iron and the effect of graphite. They referred to the possibility that white iron would behave differently and in experiments which had been carried out, white iron had behaved very differently. They had not felt it possible to give the results of those experiments in the Paper because it was very difficult, as they would readily understand, to guarantee that one did not get some decomposition of carbides during the vacuum heating process. It was now one of the tasks of the joint committee investigating that further point, using an iron of a suitable composition to prevent the decomposition of the white iron during the process. He hoped there would be some reference made to this point in the course of a few months.

Development of Vacuum Heating Methods

DR. NEWELL said, as one associated with the development of the vacuum heating method, he was pleased that Dr. Riley had applied it to cast iron, and he complimented him for having mastered a difficult technique. His main purpose was to reinforce the last speaker's remarks and make a plea that that work should be continued. When one considered the past work done on that subject, the extraction of gas from metals, and saw the vast amount of confusion early on due to lack of equipment, and then on to the stage when equipment was available, there was then confusion as to the composition of the gas which came off. They then found that this was associated with the extraction of gas from the vessels. The development of the vacuum heating method for steel was an advance, and it was then shown that with steel the gas was pure hydrogen. It was known at that time that many other materials did not give such a complete liberation of hydrogen, but that other gases were also liberated on heating. Thus, for steel, the method was established as a method of determining its hydrogen content, whilst for cast iron there were numerous difficulties. In scientific progress the exception proved the rule, and there was a clear case for further investigation to elucidate the factors which controlled the ready evolution of hydrogen from cast iron; the effect of alloy elements, the form of the carbon, etc. He felt sure that arising from that work would be found valuable information on the structure and composition of the iron, also on the mechanism whereby hydrogen passed out—whether it was combined or absorbed in the graphite flakes, and so on. He thought it would prove a valuable tool in elucidating other factors, apart from the academic interest of knowing how it was there.

For steel they had evidence that the hydrogen content had a marked bearing on the ductility of the steel, and whilst there was much more to be done to elucidate that point, he felt sure that similar results on cast iron would be found if a comprehensive programme were arranged and executed. He felt sure that the hydrogen content would be markedly influenced by the presence of structural defects in cast iron, and an accurate measurement of the hydrogen content should serve as a measure of these defects.

Voids and Gas Evolution

Another point was that Dr. Riley said he did not think the carbon monoxide came from the oxide inclusions in the iron. Possibly he was right, but if he was right, the quantities of oxygen that were absorbed in the voids were very large, as indicated from the gas composition given, and he thought they had to strain their imaginations to accept such large quantities of gas in the small voids which they believed to be present in the cast iron. He thought they might find that in all probability the oxygen, or carbon monoxide, would at least be absorbed by some constituent in the iron, and the manner of its

absorption would be of great value to know. The amount of carbon monoxide which was given off from steel was extremely small, due to the fact that iron oxide did not diffuse or migrate through the iron to any marked extent. Nevertheless, small concentrations of carbon monoxide were given off from steel at high temperatures, and it had been shown that from the change in the pressure of the carbon monoxide with temperature the identity of the form of oxide present could be indicated by thermodynamic reasoning.

Work on those lines would, he felt sure, throw light on the question of whether the oxygen was there as oxide or carbon monoxide or absorbed. Numerous other aspects did arise which would lead them away from the field of the determination of hydrogen. One was the determination of the nitrogen evolved, which he thought would be most valuable as determining the form in which the nitrides were present, which would probably have a bearing on the mechanical properties.

He made a strong appeal that that work should be extended and continued for a considerable time and that great care should be taken so that all the implications from the results might be obtained.

A Plea for Extension

DR. RILEY said he was not attempting to damp the spirits of investigators, for he would like to see that work carried on on a much wider scale, but he would like the practical men among them to realise that they could not expect quick results. He had a feeling that a couple of years ago when the joint committee was formed some members were feeling that their troubles were at an end and in a month or two something concrete would come out of the work on gases and they would be able to apply it immediately in the foundry. Nothing like it was likely to happen. Except in a number of isolated cases they had found difficulty in co-relating that work with a single foundry problem. In certain instances it had been extremely valuable and had amply repaid the time and money put into it. But for the general problems he would say that years and years of work would be necessary and the more people who got into the field the better. Vacuum furnace equipment was not only expensive, but the time taken for the experiments was long. He would support Dr. Newell's point of view that the work should be extended and that it should be extended at all levels, at the academic level and the relatively practical level. He thanked Dr. Newell for his references to gases and the ductility of steel, which was a point he had not fully appreciated. That might prove to be very valuable.

As to whether the relatively large amounts of hydrogen and other gases could be retained in voids in iron was, he admitted, very problematical, and for that reason he had tentatively advanced the parallel theory that there might be absorption or adsorption, or combination in some way with the carbon and the graphite. He agreed that the nitrides were important, and to hark back to a previous Paper, they had shown quite definitely that cupola-melted iron was different from blast-furnace iron in that respect. The cupola iron generally showed a higher nitrogen content.

Atmospheric Influences

MR. PIERCE put a practical foundry problem. When the humidity of the atmosphere was high they experienced gas holes in centrifugal castings. Was that due to the extra absorption of hydrogen from the cupola metal? Was that a possibility? Did the metal absorb more hydrogen when the atmosphere was humid, and, if so, was it possible that the hydrogen could be spun out in a centrifugal casting?

DR. RILEY said they were important points and ones which had not escaped their attention. They had attempted to see whether humidity did affect the hydrogen content of the iron, but unfortunately they had not the necessary number of results in order to be completely satisfied. The indications were that humidity did affect the hydrogen content of iron; that on summer days when the moisture content of the air was high there was an indication that the hydrogen content might be slightly higher. They had found, for example, that casts of iron made on the same day from the cupola bore a striking resemblance to one another. They were not certain at the present stage whether that was due to the humidity, the raw materials being used, or to the treatment of them.

They had done some work on occluded gas in centrifugal castings, but it was too early yet to give an answer to the question by Mr. Pierce. The tendency seemed to be that there was some reduction in gas content possible during centrifuging.

Gases from Horse-shoe Nails

MR. JOHN HIRD referred to experiments carried out by his father 30 years ago, to collect gas given off when metal was poured into a mould, and said the quantity obtained from a small casting was amazing. On analysis with very elementary apparatus it was found that there was a quantity of hydrogen and nitrogen present. That was interesting in as much as Dr. Newell had said that experiments had been going on for a long time. That was the first one he had known of. They did not get any satisfactory results because it was too crude.

The other point he wished to make was that in the case of "steel" they had had an unfortunate experience some years ago in casting cylinder heads. It was about the time that the idea of putting horse-shoe nails into thick sections was having a vogue. They started off satisfactorily and then ran into a whole series of blow-holes in the vicinity of the horse-shoe nails. They found that the only difference was a great increase in the sulphur content of some of the horse-shoe nails. Their buyer had found a cheap lot of horse-shoe nails, whereas the original nails were specially produced for the purpose and were of a relatively good iron.

DR. RILEY believed work had been done recently in which large quantities of gas had been collected from molten iron. Experiments of that kind were fraught with innumerable practical difficulties and it was still very problematic whether anyone had sampled gases from molten iron properly. The problem was that they would have oxide films on all materials used; the wrought-iron pipe would probably have a film, even if it was not visible. There

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would have been some film of gas there and all that would give rise to large volumes of gas which had nothing whatever to do with the gas from the metal. That was one of the troubles found in connection with the taking of gas samples from liquid iron.

The point about the horse-shoe nails was interesting, but he could not add anything further.

Delayed Action

DR. NEWELL said with regard to the effect of the atmosphere on hydrogen content, he had for a number of years kept a record of the humidity of the atmosphere and the moisture content of materials used in steel-making. They had come to the conclusion that it was not so much the humidity of the atmosphere at the time as the moisture content prior to that; whether the materials used for the steel-making were actually wet or not. The incidence of trouble due to the hydrogen content was found to be not due to high water content at the actual time the steel was made, but due to the wet periods prior to that when the materials had been stored and were possibly taking up water.

Conditions in iron-making differed in that they had the air blowing through at a high rate, but he thought the same would apply, that the moisture included with the materials would be of more importance than the amount of water vapour in the atmosphere at the time

DR. RILEY said he associated himself entirely with those remarks.

MR. FLEMING asked if he might cross-question Dr. Newell as to whether he was speaking of Siemens process steel, Bessemer steel, or some other method? As a side issue and a comment he had noticed that there had been considerable evidence put forward from workers in America, that the chill depth associated with a given composition of cast iron did vary with the humidity.

DR. NEWELL said the answer to the question was that it was electric arc steel-making, and it would seem on the face of it that humidity of the atmosphere would have quite a bearing on the hydrogen content of the steel made in the electric-arc furnace, from the fact that the water might be dissociated at the high temperature.

With regard to Mr. Fleming's point, in American steel practice, where humidities could be extremely high, no correlation had been found between the high degree of humidity and the hydrogen content of steel.

A MEMBER said it was a point which could be debated considerably. In the cupola if they charged damp materials the possibility was that they would drive out the hydrogen before they got the metal down to the melting point. But in the air blown through, the air was actually going through the molten metal, and the different degrees of humidity as between a cold dry day and a moist and humid one would make a considerable difference in the gallons of water actually blown into the metal. He thought from that point of view it might make a considerable difference, particularly when they took into account that water decomposed into hydrogen and oxygen, and those elements were gases.

MR. YOUNG commented that he had been working an ironfoundry in Manchester and had taken humidity records. He had found no evidence at all that more wasters arose during periods of high humidity, nor had he met anyone willing to listen to it as an excuse for higher wastage. On the other hand, he was not then making individually-cast piston rings, which castings obeyed a set of laws of their own.

Personal

MR. FREDERICK BILTON has resigned from the board of Vigzol Oil Refining Company (London), Limited.

MR. W. A. ROBOTHAM and MR. J. D. PEARSON have been appointed directors of Rolls-Royce, Limited, Derby.

MR. G. O. CLARK has been appointed an additional director of Bells Asbestos & Engineering, Limited, Slough.

MR. P. C. E. ROSE has been appointed a director of the Saunders Valve Company, Limited, Cwmbran, Newport, Mon.

MR. F. P. WALKER has resigned from the board of the Crittall Manufacturing Company, Limited, manufacturers of metal windows, etc., of Braintree, Essex.

SIR ALFRED EGERTON, F.R.S., Professor of Chemical Technology at the Imperial College of Science and Technology since 1936, has been awarded an honorary degree by the Finnish Institute of Technology.

MR. JOSHUA WHITFIELD, commercial manager in the engineering department of William Doxford & Sons, Limited, shipbuilders, of Sunderland, has retired at the age of 65 after almost 40 years' service with the company.

MR. JOHN LOUDON, a superintendent of assembly employed by Hoover, Limited, Cambuslang, has won £250 and a two months' course at Cambridge University for a thesis on the "Selection and Training of Foremen." He was one of the competitors in the annual Sir Henry Fiddes gold medal competition, which is organised by the Institution of Works Managers and is open to all works managers and supervisors in Britain, who are members or affiliated members.

Wills

CLERKE, MAJOR A. B. H., late joint managing director and deputy chairman of Hadfields, Limited, steel manufacturers, of Sheffield £47,235

ROBERTS, W. R., one of the founders and a director and secretary of Roberts & Armstrong (Engineers), Limited, North Wembley, Middx ... £7,638

JONES, J. H., joint managing director of the Coalbrookdale Company, Limited, ironfounders, of Wellington, Salop, James Clay (Wellington), Limited, agricultural engineers, and the Sinclair Iron Company, Limited, Wellington, and a director of Allied Iron (R.W.), Limited, Wellington £7,687

Making Special-duty Castings in Aluminium Alloys*

By J. Caven and H. W. Keeble, A.I.M.

It is not generally realised that aluminium ranks next to steel in the volume of world output of metals. Further, the volume of aluminium now produced is practically equal to all the other non-ferrous metals put together. It is the only metal in general use which is cheaper to-day than it was in 1939. Other non-ferrous metals, such as copper, zinc, etc., have very considerably increased in price. In 1939, the output of castings from aluminium-alloy founders was of the order of 12,000 tons per annum, of which an appreciable proportion was for the aircraft industry. During the war, peak output at the rate of 65,000 tons per annum was reached in 1943-44 almost solely for aircraft purposes. During 1947, 45,000 tons of castings were produced, practically all of which went into general-purpose consumption. This fourfold increase in peacetime consumption is not surprising in view of the technical and commercial advantages arising from the use of aluminium-alloy castings.

Production Factors for Consideration

The castings described in this Paper were made in a large foundry specialising in the production of high-quality aluminium-alloy castings of any size in large or small quantities for all branches of industry. The production floor activities are supported by patternmaking, heat-treatment, inspection and laboratory services, including examination of castings by X-ray. Each of the castings was produced by a technique influenced by:—(1) Character of the casting; (2) the foundry behaviour of the alloy in which the casting was to be made, and (3) the number-off required and the likelihood of repeat orders.

Factors (1) and (3) are readily understood, but unless what is involved in (2) is appreciated, some aspects of these production techniques may appear unusual, especially to those normally associated with cast-iron practice. The fundamental features of aluminium alloys requiring comment may be detailed broadly as follow:—(*a*) Specific gravity, and (*b*) solidification shrinkage.

(*a*) *Specific Gravity.*—Aluminium casting alloys have values of 2.6 to 2.9 compared with 7.0 to 8.5 for cast iron, steels, bronzes, etc. This means that the hydrostatic pressure in pounds per square inch per foot depth is about one for aluminium alloys and three, approximately, for the other materials mentioned. This difference affects the design of risers and their distribution over the casting. Another effect is the ease with which mould and core gases may penetrate the metal to cause blowholes. This feature emphasises the importance of mould and core permeability and usually requires, on the part of the moulder, an adjustment in ramming technique when changing from, say, cast iron to aluminium.

(*b*) *Solidification Shrinkage.*—When passing from liquid to solid (liquidus-solidus range), there is an overall freezing shrinkage of between 6 and 8 per cent. (exclusive of liquid shrinkage and solid contraction) for pure aluminium and its alloys. The eutectic silicon alloy 2L33 is the one exception; this alloy has a freezing shrinkage of around 3.5 per cent. For grey cast iron this value ranges approximately from nil to 1.5 per cent. expansion due to formation of graphite structure. For mottled and white cast irons, the shrinkage is around 3.5 per cent., and for copper-base alloys it is at the 4.5 per cent. level. This difference makes necessary—in combination with effects of specific gravity—a vast extension in provision of adequate feed risers and extensive chilling to deal with the very heavy solidification shrinkage.

The aim of the founder is to introduce the metal into the casting in such a manner as will ensure that solidification proceeds towards the feed risers. Their shape and volume controls the amount of heat available to maintain the right heat flow or temperature gradient necessary to ensure that solidification shrinkage is fully met in the casting. The amount of heat released on freezing (super- and latent heat), relative to the rate at which it is abstracted by the mould, controls the rate of solidification in the casting walls. The quicker the section solidifies (within limits), the more self-feeding occurs during pouring and the less the need for external feed riser provision. This feature in conjunction with the heavy solidication shrinkage, partially explains the extensive use of chills, particularly where thick sections are concerned, in alloys of certain solidification habit.

It is only by an understanding of these factors that some aspects of the technique described hereafter may be fully appreciated. All the castings concerned were made in natural moulding sand based on Mansfield and Birmingham red sands. The A.F.S. permeability values were around 40, with green-bond strengths of 6 to 8 lb. per sq. in. at 5 to 6 per cent. moisture. Where oil-sand cores were concerned, these were made in Southport sea sand with a bond of linseed oil and molasses. Chills in cast iron and aluminium were employed. For use they were dressed with iron oxide or oil and dried off by flaming. If in continual use they were shot-blasted occasionally to remove "build ups" of spent coating, rust, etc.

*A Paper read before the Birmingham Branch and the Slough Section of the Institute of British Foundrymen. The Authors are technical manager and chief metallurgist, respectively, at William Mills, Limited, Wednesbury.

Special-duty Aluminium Castings

Casting Made with Tubular Inserts "Cast In"

Inserts are often cast in in aluminium alloy castings to provide improved properties at local points, such as valve seatings, holding studs, pipe unions and oil passages for lubrication and cooling where machining of the passages would be difficult or even impossible. The inserts may be of steel (carbon or austenitic), cast iron, bronzes, or in the form of copper and steel tubing. An example of a casting containing a cast in copper coil is described in what follows.

The gland casting, shown in Fig. 1, for holding an electrode for an 11,000-k.v.a. electric furnace, provides a good example of the foundry technique involved in this class of work. The insert takes the form of a double coil made up from 85 ft. of 1¼-in. dia. copper tube with inlet and outlet flanges through which oil is passed for the purpose of controlling the temperature of the electrode assembled in the centre of the gland. Details of the casting were approximately as follow:—28-in. dia., 27 in. long, with top flange, 36-in. dia.; weight of unfettled casting, 600 lb.; weight of fettled casting, 260 lb.. weight of copper coil, 120 lb.

FIG. 1.—GLAND RING. FINISHED CASTING—RIGHT; OIL-CIRCULATING COIL—LEFT.

Special arrangements were made for supporting and assembling the coil to provide against its movement during pouring, and distorting because of heat. The gating arrangement was designed to give quiet entry without turbulence, a minimum flow across the coil, and hot metal at the riser level to feed the thick sections above the coil. To achieve these conditions a three-part moulding box was used with joints at top and bottom of the pattern. Fig. 2 shows schematic presentation of mould arrangement.

Mould Assembly

Pattern and core box equipment provided for the centre dry-sand core A to extend through the riser B to the top of the mould. Oil-sand cores C split at the centre line of the coil inlet and outlet branches formed the pocket between the two casting flanges. This allowed the coil to be assembled into the mould. Oil-sand core E formed the irregular shape at the gland base and seating for centre core A. Gates F were attached to the pattern and fillet chills were placed along the gate/casting junction to ensure soundness (see scrap section). The mould was rammed in green sand and carried chills on the underside of the middle flange. The mould was dressed with French chalk and skin dried.

Prior to assembly on core print E sitting on locating plate G (external to the mould) the coil had been prepared with:—(1) Extended inlet and outlet branches (D and P); (2) six ¼-in. dia. screwed copper rods M; (3) ¼-in. dia. rods N; (4) brazed jointings at places between coil layers for strength of coil shape; (5) sprayed with low-carbon steel 0.03-in. skin; (6) pressure tested to 150 lb. per sq. in.; (7) shot-blasted.

The coil position was adjusted by nuts O and finally locked by screwing down nuts J. A lifting bolt was screwed into the centre tapping K in plate G and the coil assembly crane lifted into position in the mould. Bolts were inserted through slots in drag bars, screwing into tappings L. After locating the whole coil position by adjusting position of branches D and rods N, it was tightly bolted to the drag box. Extension pieces P were screwed into branches D by being passed through holes in the box walls. The top sections of ring core C and centre core A (provided with plate R and bolt T) were assembled. The runner box was placed in position and preheated runner tubes of ¾-in. bore steel fitted into 4-in. downgates H. These tubes cleared the bottom by about 1½ in. and were dressed with a whiting/silicate wash to minimise chilling action and metal attack. Eye bolts Q fitted to the supporting collar at the runner box facilitated their placing and withdrawal upon completion of pouring.

Meanwhile the coil inlet branch had been fitted to the compressed-air line (80 to 100 lb. per sq. in.) and the outlet branch piped (metal) away for safety reasons.

During pouring the emerging air stream was exceedingly hot. A piece of wood held in the stream would immediately char, and canvas-lined hose would burn through in a few seconds.

Pouring and Finishing Processes

For pouring, a geared ladle was used. After placing ball stoppers into position over the runner tube mouths the runner box was filled to capacity. When full the stoppers were lifted and pouring proceeded in the normal way by keeping the runner box full. At the same time the compressed air was turned on and kept on until the casting was solid and partially cooled. The purpose of the compressed air was to keep the coil cool, thereby minimising distortion and likelihood of burning on. Also, to cause solidification to start around the coil so that good heat transfer conditions were achieved which were a necessary feature of its service performance.

A metal pouring temperature of around 720 deg. C. was used, which was high in relation to the flange section thicknesses of the casting, but was necessary to avoid lapping and misruns because of the chilling action of the coil. The top riser was rod fed and supplemented at intervals with supplies of hot metal.

The chilling action of the coil assembly quickly cooled the incoming metal, pushing the new metal stream back into the gate, thereby ensuring that the metal entered the mould off the rising metal within the downgate (see Fig. 3). Stripping and fettling were carried out in the normal way using pneumatic chisels, grinders and bandsaws. The protruding ends of rods M and N were cut off and surface filed flat. After pressure testing, X-ray examination was made to check coil position relative to the casting walls.

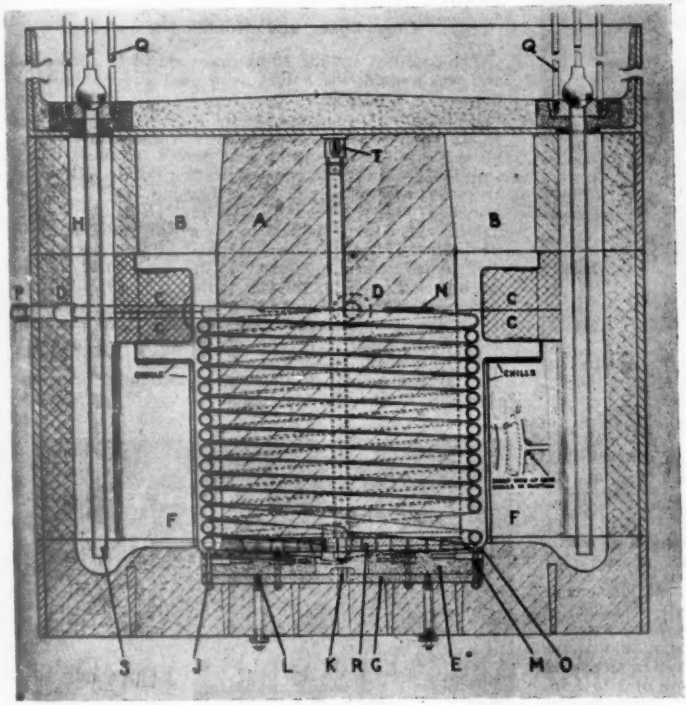

FIG. 2.—MOULD ARRANGEMENT FOR THE GLAND RING CASTING.

Preparation of the Metal.—The casting was poured in silicon alloy 2L33. As is well known, this material has a solidification shrinkage value of 3.5 per cent., as compared with 6 to 8 per cent. for other aluminium alloys.

It has excellent flowing power, being a eutectic alloy, and has a low (comparatively) contraction rate. These characteristics make it an attractive alloy to handle in the foundry for work involving large thin areas, etc. On the other hand, the alloy solidifies at a single temperature as distinct from over a range of temperature. This means that there is no pasty range (liquidus-solidus) in the freezing cycle, which allows time for feed metal to travel to compensate for the shrinkage which occurs. Consequently very severe piping cavities are often seen in silicon alloy castings which contain thick sections unless severe chilling and feeding arrangements are made. Further, the shrinkage habit of the alloy and its general behaviour are affected by a number of variables, some of which are known and others which are less perfectly understood.

These are associated mainly with:—(*a*) Composition, including silicon content and the normal impurities such as iron, manganese, copper, etc., also the trace elements such as calcium, phosphorus and titanium; (*b*) gas content, which is associated with the method of making the original ingot and the style of re-modification treatment, and (*c*) re-modification technique, including temperature and time factors, furnace type, whether modified with sodium or sodium salts, etc., ratio of ingot to scrap in metal charge.

In view of these comments on the shrinkage habit of the alloy, it is strongly advised that ingot is pur-

Special-duty Aluminium Castings

chased only from manufacturers of repute, to a definite specification in terms of analysis and condition of modification. The excellent flowing power and low contrac-

FIG. 3.—DOWNGATE, INGATE AND FEED RISER FOR THE GLAND RING CASTING.

tion rate of 2L33 make it the most suitable alloy for casting-in a copper coil of the size and weight involved. The metal required was melted in oil-fired crucible furnaces, modified with metallic sodium and carried to the mould in geared ladles.

Castings Requiring a Mould Construction with Extensive Use of Chills

The scavenge pump cylinder for marine engine application shown in Fig. 4 is an example of a class of castings made by techniques embodying free use of chills. The casting was made in 2L33 alloy and details were as follow:—(1) Approximate overall dimensions. 3 ft. 6 in. square by 4 ft. long and a bore of 2 ft. 6 in. dia.; (2) unfettled weight was 850 lb.; (3) fettled weight was 650 lb.; (4) sectional thicknesses were from 0.75 to 1.5 in. and were considerably more at section juncture, and (5) the casting had to be pressure tight.

In making the casting the following factors had to receive consideration and the technique arranged accordingly:—(1) Wall thicknesses were heavy and section distribution was such as to be frequently isolated from external feed arrangements; (2) shrinkage habit of the silicon alloy, and (3) since heavy chilling was necessary, particularly on the 30-in. bore, the arrangement had to allow for loosening and removal of chills immediately after solidification to avoid generation of internal stress and, possibly, cracking.

The pattern and core box equipment was designed so that the cylinder was moulded and cored in the horizontal plane. To ensure a clean bore after machining and secure directional solidification, the mould was turned on end for pouring. A schematic layout is shown in Fig. 5. The pattern was jointed on centre line A with (1) ample core print at each end to carry 30-in. dia. core B prior to the mould being turned on end; (2) shallow core prints C to locate the port and recess cores forming the four faces of the casting, and (3) core-prints D to fix cores through which the downgates passed.

Core Boxes and Moulding Tackle

The core box for the 30-in. dia. bore had closed ends and was jointed; the halves were used as separate core boxes. The port and recess core boxes were made so that the cores turned out on the core print faces. To secure rigidity of core assembly when the mould was turned on end for pouring and permit removal of the chill-faced core after solidification, the following arrangements were made:—(1) The moulding box was provided with a 34-in. dia. end plate E made in two halves, which were held in position with bolts; (2) two 5-in. dia. apertures F were arranged to permit the 4-in. dia. runner bars to pass through the end of the moulding box and connect up with runner box; (3) box bars were placed so that port and recess cores were bolted in position from outside of the moulding box, and (4) adequate joint flange for bolting the two half-moulds securely together was provided.

Moulding technique followed that used in the previous example. Great care was taken, however, in the plac-

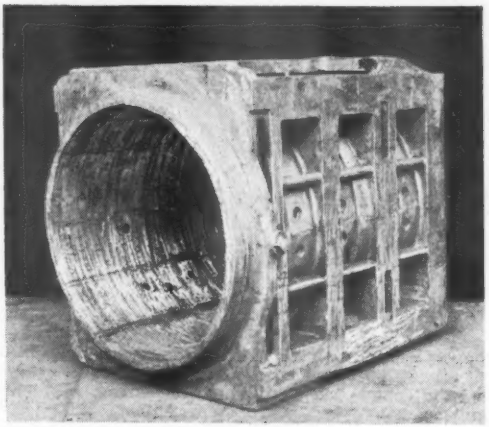

FIG. 4.—SCAVENGE PUMP CASING FOR MARINE USE, AFTER FETTLING.

ing, sprigging and wiring the chills to the face of the mould because, when in the vertical position, the chills were hanging on the side walls and liable to drop if not securely fixed (see Fig. 6). The 30-in. dia. core B

(Fig. 5) was made in two halves carried on separate grids G and bolted together by means of bolts in slots in the ends of the grid after assembly in the mould.

The face of the core was completely covered with perforated iron and, later, aluminium chills H (Fig. 5) approximately 15 in. by 7 in. by ½ in. thick. Each chill carried two or more cast-in studs. They were placed in position on the face of the core box and sand was rubbed into the joints. The grid G, to which a rectangular tapered bar J had been secured with soft iron wire, was placed in the box and held supported by bolting lugs which extended past the ends of the box. The chills were securely wired from the studs to the tapered bar J. The half-core was completed by ramming in floor sand with graded coke down the centre for venting and lightness. This method ensured its being reasonably soft. After stove drying, the core halves were prepared for assembly by cleaning and re-dressing the chill faces.

This operation was carried out as late as possible to avoid sweating on the chills. The port and recess cores C and gate cores D were made in oil-sand and carried on grids tapped to receive bolts K inserted from outside the moulding box. After their assembly in the mould, they were securely bolted in position, thereby stiffening the mould construction generally and permitting the "turn on end" operation with little risk of internal movement. The placing of the drag half of the main core followed and the clearance between the end of the core and the 34-in. dia. end plate E was rammed-up. The top half of the main core was then placed in position and bolted to the drag half at the grid ends. The top half-mould was now closed on and the two halves bolted together. The clearance between end plate E and top half of the core was rammed solid from outside the box. This packing had to take the weight of the main core, including chills, some 2,600 lb. approximately when in the vertical position. The whole assembly was placed on end and turned into position for pouring. The final preparation consisted of sealing off box joints, ensuring that the bottom vent from the main core was clear, and placing the runner box into position.

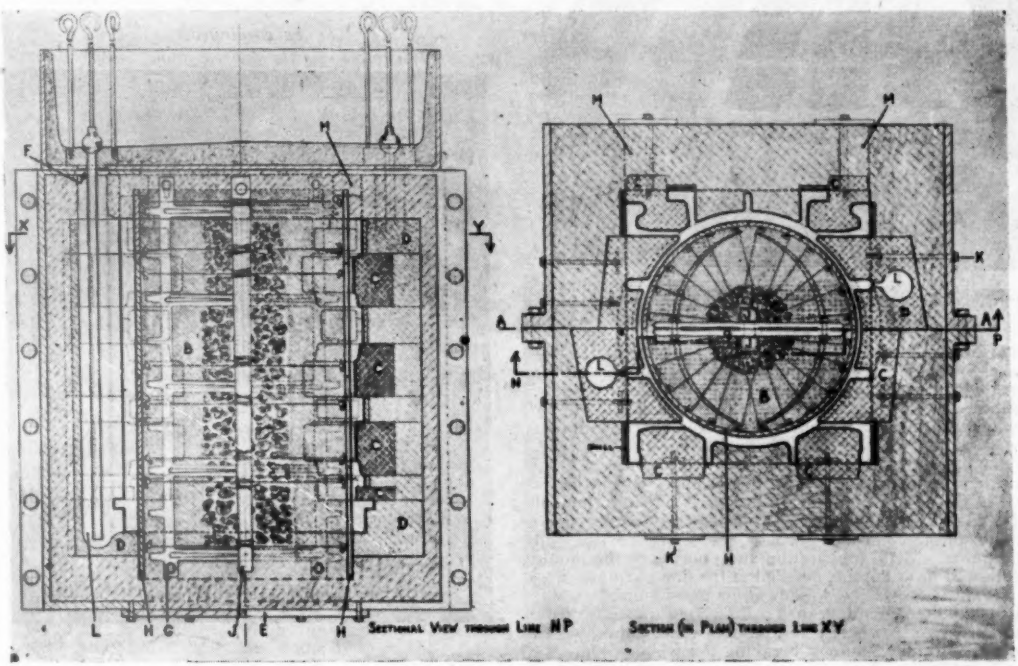

FIG. 5.—LAYOUT OF THE MOULD FOR THE SCAVENGE PUMP CASING.

Gating Technique

The gating technique was similar to that used on the oil-cooled gland casting, *i.e.*, two tube downgates, plunger controlled, linked to the mould by a continu-

Special-duty Aluminium Castings

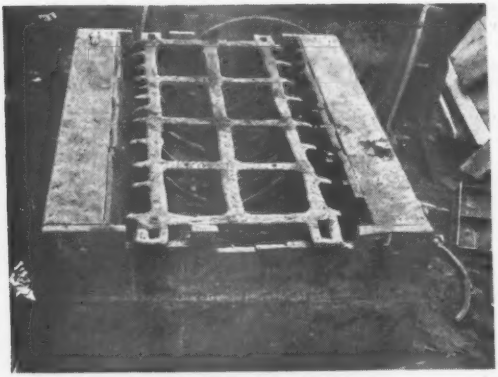

FIG. 6.—CORE BOX FOR THE SCAVENGE PUMP CASING WITH THE CHILLS AND MAIN GRID IN POSITION.

ous panel (ingate) up the full length of the casting. It was not possible, because of the casting design and the method of moulding employed, to provide feeder heads. Solidification shrinkage was therefore largely met by heavy chilling of the metal (self-feeding) as pouring proceeded, and was not dependent on external feed. Four relatively small blind risers were placed at the corners of the top face of the casing. To facilitate clearing of any turbulence developed by fluttering off the chills, two flow-offs M (Fig. 5) were arranged so that "flushing through" could be practised if thought desirable. Metal preparation and pouring of the mould followed procedure as detailed in the first example.

Immediately after solidification the runner box was lifted and core sand cleaned away round the ends of the tapered bars J (Fig. 5). These bars were withdrawn by overhead crane, thereby breaking the wires holding the chills and generally loosening them inwards on the core. This prevented the chills being locked on the casting and impeding subsequent contraction.

The cast-up mould was then turned over to a horizontal position. This permitted removal of bolts holding the grids in the port, recess and downgate cores C and D (Fig. 5), and the 34-in. dia. plate E, which in turn facilitated the removal of the main core B by working from both ends. The fettling was finished in the usual way by removal of the panel ingates and flow-off risers and grinding down any chill-joint marks in the bore. Fig. 7 shows the casting before fettling.

(To be continued.)

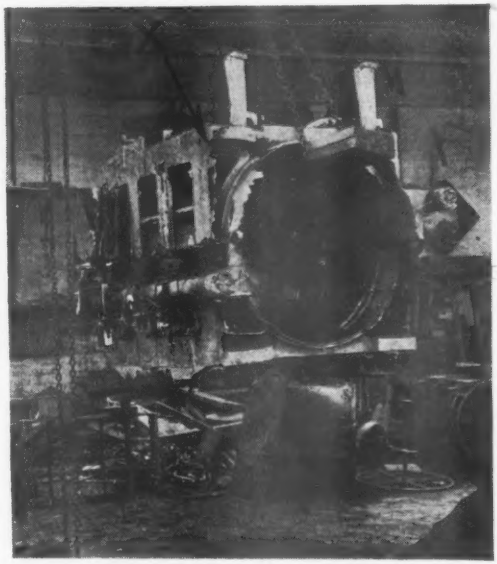

FIG. 7.—SCAVENGE PUMP CASING AS REMOVED FROM THE MOULD. ONE OF THE BLIND RISERS IS SHOWN AT X, AND ONE OF THE FLOW-OFFS AT M.

Bronze Foundry Film

The film, "Bronze Founding," which has been sponsored by the Association of Bronze and Brass Founders, was shown by the Eyre Smelting Company, Limited, at Tandem Works, Merton Abbey, London, S.W.19, last week, and also at the Wimbledon Technical School. In addition to personnel from the Eyre Smelting Company, visitors from other foundries in the London area were able to see this interesting and well-produced film. At the Wimbledon Technical School, students were shown a range of castings and finished bearings produced from gunmetal and phosphor bronze.

Technology Scholarships

Following our announcement last week of the establishment of 50 post-graduate scholarships to be awarded for study of technology in America, the Economic Co-operation Administration has announced U.S. university places for eight British scientists and technologists. Following their academic work, these men will be placed in American factories to get actual experience in American methods and techniques. Amongst the students are Mr. W. E. Dennis, of Kettering, Northants, who goes to the Carnegie School of Technology, Pittsburgh, Pennsylvania, to study physical chemistry of steel-making, and Mr. H. W. Paxton, of Moss Side, Manchester. He is to study metallurgy at Carnegie School of Technology.

American Steelfoundry Industry

First Productivity Team's Report

The first productivity team to visit America under arrangements made by the Anglo-American Council on Productivity represented the steelfounding industry. The team was drawn from the supervisory, the technical and the workshop levels in the industry, and its investigations in America occupied six weeks. Its Report is unanimous. Part 1 of the Report makes a general survey of the investigations; Part 2 outlines the purpose and programme of the tour; Part 3 contains a close and detailed examination with many illustrations of American foundry techniques; Part 4 consists of conclusions and recommendations. Later sections explain the manner of the team's selection and its method of inquiry, and there are acknowledgments of the generous help given to the team both in America and this country. The digest which follows is mainly taken from Parts 1 and 4, but other sections have been drawn upon to elaborate points made in Part 1.

Relative Productivity

After acknowledging the warm and friendly reception given to the team in America, the Report proceeds to define productivity and to set out a formula by means of which to compare productivity in Britain and the U.S.A. Productivity is defined as "the ratio of the production of wealth (goods, services and human satisfaction) to human effort expendable." Applying the definition to the specific case of steel castings, the Report says:—

> Although accurate measurement is not possible, the ratio of man-hours per ton (M.H.T.) may be taken as a broad indication (inversely) of productivity and on that basis the productivity in U.S. steelfoundries is between 50 and 90 per cent. greater than that in British.

Figures of productivity in the American steelfoundries were given to the team by Mr. C. W. Briggs, technical director of the Steel Founders' Society of America, as: open-hearth, 90 M.H.T., and electric steel, 110 M.H.T. (long tons). Complete figures are not available for British steelfoundries, but figures from the companies represented in the team and covering approximately 25 per cent. by weight of the total British output have been calculated in line with the U.S. methods. On the basis of an average 44-hr. week, the result for the British steelfoundries is 166 M.H.T.

> Such a disparity is more than can be accounted for by marginal errors of measurement. The conclusion is inescapable that the productivity of the American steelfoundry industry is markedly higher than that of the British.

Thus only by concentrating upon productivity in terms of man-power can improvements be made in the use of man-power. The fundamental causes of high productivity in the U.S.A. are found to be mainly psychological. "There is a widespread productivity consciousness in the U.S.A. and recognition that high productivity is a benefit to all concerned."

Factors Aiding Productivity

The Report draws attention to the influence in America of the compulsions of fear and competitive-

MR. F. A. MARTIN, O.B.E.,
Leader of the British Steelfoundry Team.

ness against a background of constant endeavours to attain higher standards of living, and sets out the contributory means to productivity as follows:—(1) Good factory layout and tidiness of working; (2) use of power and widespread acceptance of machines to replace man-power; (3) economy in the use of labour; (4) standardisation of output, and (5) application of the results of research.

Judged by British standards, labour in U.S. steel-

American Steelfoundry Industry

foundries is conspicuously unskilled and trade union organisation is not on a craft basis. There is a large proportion of coloured workers and mid-Europeans. Great economy is exercised in the use of skill. The careful servicing of skilled men, so as to concentrate their energies on skilled operations, was one of the most important observations made by the team. Much higher wages in the U.S.A. can buy a standard of living only slightly higher than in Britain owing to the difference in the cost of living. Against the slightly higher standard of living must be set a lesser social security enjoyed by the American steelfoundry workers. In America far greater use is made of power-operated plant for handling materials. In this respect American practice has gained the lead largely because of the repetitive nature of the work performed and its amenability to mechanisation. The adoption of equipment for non-destructive testing is widespread.

Differences in Technique

An outstanding difference in production methods is the general use in the U.S.A. of acid electric melting and the application thereto of power inputs twice as great as in equivalent arc-furnace installations in Britain. Ability to employ this economical technique comes of the good quality of scrap available. In metallurgical practice the trend is towards producing steels to meet physical test specifications, rather than analytical limits. The quality of American steel castings is satisfactory, and functionalism is the criterion of satisfaction. This has considerable effect on productivity. The production techniques and methods of the industry in the U.S.A. are examined in detail and there are many illustrations of plant. These will be extracted in a forthcoming issue.

The principles of management are discovered to be founded on general acceptance of the virtue of high productivity. In this connection the Report states:—

> First, last and all the time, managements are actuated by the belief that high rates of production are essential to individual and collective success.

And again:—

> First, last and all the time, workers at the bench, at the machine and in the office subscribe to the same belief.

And finally:—

> . . . This belief is not simply intellectual appreciation; it has a firm emotional hold upon the whole body of American industrial thought.

The aim of management is maximum output from the minimum labour force. Labour saving, reduction of the grade of labour required, together with maximum mechanisation and control of sales to encourage a higher order of repetitiveness, combine with a careful attention to maintenance of mechanical plant and willingness to try new methods, in developing maximum output from the minimum labour force.

Rôle of Skill

Where is the skill in American steelfoundries? The Report answers thus:—

> To state that the U.S. foundries are practically devoid of skilled craftsmen, although superficially true, gives a completely false impression . . . But the exercise of skill has been taken from the shop floor into the pattern shop, the methods office and the brains of the supervisors. A supply of skilled foundrymen being lacking, the U.S. foundries have set about making steel castings in such a way that skilled moulders are not required except for a vanishing percentage of the work. Even small runs —as few as eight off one pattern—are mounted for machine moulding. Skill, in the sense of ability to plan the production methods required to produce sound castings without wastage of material, remains very much in evidence.

After describing the method of up-grading labour, the Report goes on:—

> Skill once acquired is not wasted. A man who is deemed capable of ramming facing sand is not required to waste his time fetching it; a skilled closer on an intricate job has the job so organised for him that every core, chill and chaplet is ready to hand as he requires it. In the case of multiple repetition jobs this organisation of labour is carried to the extreme of effectiveness. If jobs are not sufficiently repetitive to repay such pains in organisation, much is done by supplying services and sundries in plenty to avoid wasted effort. If a hundred lifters may be required, two hundred are at hand to avoid any need for a search. Almost invariably floor moulders are serviced by Sandslingers to complete the ramming up of backing sand.
>
> Power assistance is to be found everywhere . . . Rather than have a man spend time looking for equipment of which there is enough in the shop, provision is made to have more than enough. This is not as wasteful as it might sound since equipment does not wear out by the calendar but by being used.

Equipment

Commenting further on the amount of equipment available, the Report says that gantry cranes move at a higher speed than in Britain and the team made note of a furnace bogie that was being unloaded by a magnet crane with no one in attendance at floor level. Jib cranes are more plentifully installed. The wheelbarrow is almost extinct, superseded by fork trucks.

> A most effective time saving technique, says the Report, is that of "snatching" the casting with a magnet crane . . . . The crane approaches a pile of castings at high speed with the magnet fairly near floor level. The crane comes to a stop somewhere short of the casting, while the magnet swings forward over the pile, is dropped on to it, current switched on and the hoist begun at the same moment as the crane starts on its return journey. . . . The crane

drivers derive a good deal of satisfaction from the swinging rhythm of the process. Thanks to strident hooters the way is kept clear under the crane path.

Among many other examples of American mechanisation is that of a Sandslinger with a 34-ft. reach operated by a driver sitting at the end of the running head. The machine rams one ton of backing sand a minute and carries its supply in a 20-ton hopper. By its use, piece rates on the heavy moulding have been reduced by 37½ per cent., yet the moulders are earning more.

The standard of tidiness in American factories is high. The best does not surpass the best British practice, but the general average is better. This is not quite a comparison of like with like because it is easier to keep tidy a shop which is mechanised on a regular flow of production. "This suggests that organisation of British steelfoundries on line production principles even with jobbing work would pay dividends in tidiness and ease of control." Even when there was an impression of congestion in an American foundry the reason was found to be in a saving of waste effort. The minimum of movement was necessary for a man to dispose of work he had done and bring new work into his area of operation—"another example of the care taken to avoid wasting that most expensive commodity, man-hours."

Accident Prevention

The measures taken for accident prevention in American factories are praised—*e.g.*, compulsory use of goggles in fettling shops; protective eye shields wherever there is danger of flying particles. The same is not so true of workers exposed to danger from siliceous dust; some foundries enforce, while others neglect, the use of respirators. Practically every U.S.A. steelfoundry visited carried out regular X-ray examinations of all employees liable to dust danger. Though the equipment might not be the most perfect for the job, at least lung changes could be detected at a far earlier stage than by clinical examination. The Report makes the following observation:—

> The Americans appear to be far less interested in the reasons why something should not be done than in the important reasons why it should. So they get moving while their British counterparts wait for further information.

In the American workshops, however, the team frequently observed a sacrifice of safety for the sake of speed, in, *e.g.*, the magnet "snatching" technique, but, notwithstanding, the accident rate was reported to have fallen from an index figure of 45 to 27 in the past five years. Managements and employers were safety conscious.

CONCLUSIONS

The conclusions of the Report include the following:—

(1) The emphasis in America appears to be far more upon productivity output per man than upon total output of the plant which is regarded logically as a corollary to high productivity. Productivity consciousness is to be found among all grades, from executives to shop level.

(2) Achievement of high productivity is advantageous to everyone employed.

(3) Monetary incentives are effective because taxation does not nullify or nearly nullify the extra reward for extra effort and consumer goods are in supply to absorb the extra earnings.

(4) Incentives include not only the high standard of living but also the compulsion of fear. The consequence of falling out of a job can be disastrous. High productivity is the golden road to a better rated job.

(5) Throughout America competition is a governing factor. Price cutting becomes the rule when business levels fall.

(6) Competition at supervisory levels is keen and entry to the grade is dependent only upon ability and energy.

(7) Opposition to a course designed to increase productivity, even if it intensifies competition, is rare.

(8) An aspect of production which follows from this attitude is its apparent ruthlessness. During a recession of business there is no slackening of the tempo of working but rather does the spirit of competitiveness appear to gain fresh strength.

(9) It is not suggested that only the forces mentioned can spur a man to greater endeavour, but fear and self-interest have always wrought powerfully and require no pre-conditioning of human nature to enhance their effectiveness.

(10) The physical basis of high productivity is the use of machines. High productivity can be maintained only if the products are in sufficient numbers to justify the use of machines for making them. Acceptance of standardised units is characteristic of the American market. The ability to put quite short runs into machine production grows, though with noticeable decrease in productivity.

(11) The use of machines pre-supposes the use of more power per man and elimination of a great deal of hand operation. The readiness of the American worker to accept new machines, new methods, and the use of new materials is most evident.

(12) Since labour is expensive the best possible use is made of it; skilled men are confined to skilled work and serviced by lower grade men. Skill of a high order is retained as knowledge which may be entirely divorced from performance of any manual operation.

(13) Castings are required to be functionally adequate; defects segregated to unimportant parts do not seem objectionable to the users. Tolerances and limits are no closer than necessary to meet the duty required.

(14) Power can be obtained as required. Machinery too can be bought on short delivery times.

(15) There is free interchange of ideas and information within the trade. The results of research are reported to members of the Steel Founders' Society of America as soon as available. Many methods known in Britain but only hesitantly being tried out are already widely used in U.S. factories.

American Steelfoundry Industry

(16) Emphasis on safety, especially from silicosis, has an influence on production. The practice of X-ray examination ensures that no man will remain exposed to dust hazards long enough to be incapacitated.

(17) Coloured labour is especially valuable in the repetition processes calling for deftness combined with severe muscular effort.

(18) There appears to be little tendency in the labour unions to press any policy that would act in restriction of production.

RECOMMENDATIONS

Before setting out the team's recommendations, the Report submits two questions and asks for honest answers:—

Is high productivity really desired by British steelfounders?

Over what features in the British industrial system does the desire for high productivity take preference?

The questions are repeated in a more specific form:—Is high productivity more important than the organisation and customs of the trade association? Is high productivity to be sacrificed so as to retain intact the existing methods of the employers' organisations? Are trade union practices, built up over the years before the present economic dangers, to remain unaltered at the expense of high productivity?

The Report continues:—

What the answer must be depends upon the meaning of the alternative. Economic surveys politely use the terminology of economics. Put much more bluntly, the economic surveys tell us that the alternative to high productivity is *starvation*, and once that is understood, not only intellectually but emotionally, something can be done.

The Report insists that high productivity must be established as a touchstone of industrial conduct. Neither traditional practice nor trade custom has an export value. High productivity has. Neither precedent nor procedure can stave off starvation. High productivity can; it is the means to obtain freedom from the fear of want. "Any rule, practice or policy acting against high productivity—notwithstanding its original purpose—offends the community as a whole."

Some form of direct incentive is essential, and the incentive must be properly shared by manual workers, supervisors, managers and technicians and, in fairness, by owners and investors also. Customers must gain through reduced prices. Increased wages would be useless as an incentive without an increase in the supply of consumer goods. Here the guidance of the highest economic authorities is necessary.

The present system of calculating wages in British steelfoundries is neither simple nor sensible; simplification is overdue. By the touchstone of high productivity neither the failure of a company which works at low productivity nor the loss of his job because an employee is inefficient is to be regarded as unfair.

Technical Improvements

Concerning technical improvements, the Report says that the reconstruction of steelfoundries is a long-term matter, but may have grown haphazard and must either be made more efficient or come under the hammer prepared for the inefficient. Long-term policies will not produce quick enough effects and the short-term recommendations include:—

(*a*) Re-arrangement of machinery and work benches and reduction of unnecessary handling;

(*b*) Installation of handling machinery such as quick acting cranes, fork lifting trucks, wheeled skids and simple jib cranes to serve a moulder's working site, or fettler's or grinder's bench;

(*c*) Installation of more production machinery, with more attention to labour-saving and careful organisation of machine production to deal with small lots;

(*d*) Early experiments with large airless shot-blasts and the external operation of shot nozzles and demonstration to the industry of the results obtained;

(*e*) Since the increase of the power-rating of arc furnaces cannot be generally applied until the lag in power supply has been overcome, one or two foundries should undertake experimental work;

(*f*) Modernising of electrode control.

Safety consciousness should be developed but not confused with timidity. It should be an industrial offence to enter a fettling shop without approved eye protection. There should be more constant use of respirators in dusty areas. In the provision of X-ray examinations, American foundries surpass British. On the other hand, the standard of conditions set out in the Garrett report is ahead of American practice.

An overhaul of shop management methods should give special attention to the efficient servicing of skilled men. This can be done without waiting for a single piece of equipment.

Standardisation

As to markets, the Report points out that the present price policy of British steelfounders does not include regular price reduction for quantities. Until it does, a powerful inducement to standardisation of components will be lacking. Standardisation on the basis of compromise would be a mistake, but any element of design which is unessential should be sacrificed in order to conform to standards. This principle should apply right through the field of design.

Much is said in the Report about production techniques and also about research and the need for conveying to steelfounders (*a*) the results of research, and (*b*) precise recommendations for applying them.

Displacement of labour is to be expected as productivity rises, but opposition to increased productivity on that ground would be misguided. There would be other forms of employment for those displaced from steelfounding. "It is unpleasant to stress the alternatives which make acceptance of this compulsion inescapable. Starvation and destitution are unpleasant words, but better the words than the reality."

Steel Melting for Foundries

Frank and Profitable Discussions

The policy of holding technical conferences in a place remote from the distractions of the works, was amply vindicated last Thursday and Friday by the outstanding success of one on Foundry Steel Melting at Ashorne Hill, near Leamington, held under the auspices of the British Iron and Steel Research Association. Well over 100 delegates attended, more than half being from foundry steel producers. The programme was excellently balanced and the sequence well chosen. As Dr. Newell (B.I.S.R.A.) indicated, and as was amply borne out by the proceedings, it was necessary for delegates to form mental pictures of the technical considerations of the various individual processes of molten steel production before considering overall economic aspects.

The conference was, for convenience, divided into three sections, the first two—cupola/converter and electric-arc processes—being considered on the Thursday, and the open-hearth and general items (cost, fluidity, etc.) on Friday.

SESSION I

Cupola/Converter Processes

On the opening day, Mr. Richard Lamb (Hadfields, Limited) occupied the chair; he introduced the speakers and cleverly interposed pertinent connecting comments between the presentation of each Paper. The first was by his colleague, Mr. Cousans, on the scope and limitations of the cupola/converter process. In the unavoidable absence of the author, this was read by Mr. McNair (also of Hadfields). The body of the Paper was devoted to listing and commenting on the *pros* and *cons* of the process. Flexibility, speed of production (a two-ton "heat" every 12 to 18 min.), good physical properties for the steel, low gas content and good "life" were weighed against increasing cost and decreasing quality of materials, particularly cupola coke, the difficulty of procuring low P and S scrap, the need for desulphurising, and the high overall melting loss of 8 to 12 per cent. Summing up, the relatively short intervals between heats, which so favoured mechanised foundry practice, and the cleanliness and foundability for thin-section castings of the steel produced, were considered to be inherent features of this process. It was believed that these would mitigate for its continuance as a production scheme, provided there was adequate maintenance to reduce metal losses and no further increase in raw material costs.

Side-blown converter design was the subject of the next Paper. It was given by Mr. A. G. Robiette, of John Miles & Partners (London), Limited, who, after initially listing the limiting factors, discussed practical design considerations both of the converters and their auxiliaries. It was disclosed that, of the 15-cwt. to 7-ton capacity range, the most popular was from one to three tons; dimensions should give about five sq. ft. surface area per ton with a 10- to 15-in. depth of metal. Metal loss, though reduced by a taller body, was a function of blowing time and many converters were, the Author considered, underblown, due to inadequate blower capacity. For blowing, the Rootes-type positive blower with motor-speed regulation has proved most efficient. There were special cases where provision of a transfer bogie to pick up the body of the converter for placing on a stool for re-lining, etc., could reduce necessary crane capacity and prove a worthwhile installation; this and other layouts were illustrated by lantern slides. Future trends of body design might, it was thought, show advantages for a hemispherical bottom.

Interposed before the discussion on the above Papers was a short account (illustrated by models) by Mr. N. P. Newby, of B.I.S.R.A., of experiments which are being conducted to take into account the aero-dynamic aspects of side-blown converter operation; these have already been referred to in these columns.*

Practical Developments

Dr. Newell, in the general discussion which followed, as a continuation of Mr. Newby's report, mentioned that a "periscope" was being constructed to observe reactions during the actual blowing of a converter. Other remarks concerned the application of the hot-blast cupola for producing improved converter metal, the plea in the interests of conservation that cupola coke should be used only for cupolas and not for general purposes, and some divergence of opinion on relative merits of fans and blowers (Mr. Robiette quoted 20 per cent. lower energy consumption per ton of metal in favour of blowers). Mr. F. A. Martin, O.B.E. (Samuel Osborn & Company, Limited) said that only 15 out of 265 United States steelfoundries possessed cupolas, and the 20 converters in use there produced a mere three per cent. of the total steel-for-castings output. Cupola/electric furnace or triplex cupola/converter/electric processes were said to have possibilities and the Ford plant in Leamington was quoted as an example of the successful application of the latter. Mr. A. Catton (Catton & Company, Limited) said he eagerly awaited the Papers on converter economics, but thought the increasing cost of coke would soon remove any advantage the side-blown process possessed. At his works, oxygen enrichment was practised, metal blowing loss was controlled by reducing total blast volume, and a shallow (9-in.) bath was favoured.

After a short break, the presentation of two further Papers and discussion of them completed the morning session. The first—on sulphur and phosphorus control—by Mr. A. J. Langner (B.I.S.R.A.), outlined first the difficulties to be contended with, due mainly to the

*Conference on Cupola and Converter Refractories, May 19, 1949 issue, page 471.

Steel Melting for Foundries

fact that FeO in a slag favours the removal of P, but prevents that of S, and then discussed practical trials which had been made. Despite a large number of experiments with a very wide variety of materials, the soda-ash treatment (or, better still, the double-ladle treatment as practised at the works of Catton & Company, Limited) had proved best for S removal. Phosphorus removal was still very difficult; some success had attended the "Perrin" process and similar processes, while to "cut the knot" a basic side-blown converter was to be tried. The final paper of this session, by Dr. Newell, was in the nature of a summary of the general potentialities of oxygen enrichment as a means of reducing some of the economic factors which seemed to be piling-up against continued use of side-blown converter plant. Where exit-gas temperatures, as in the converter, were high, there was a better case for enrichment than when, as in the cupola, they were low. This was because the enormous heat loss represented by the hot gases could be reduced if less volume were used. For the cupola, however, advantages claimed for enrichment were faster melting and higher metal temperature, permitting a higher steel component of the charge, lower silicon in converter metal, and shorter blowing times as a net result. A third use of oxygen was related to its use as an emergency tool—*e.g.*, the oxygen lance or temporary cupola-blast enrichment to remove scaffolding.

More than 20 speakers contributed to the discussion which followed this section and the nature of their contributions disclosed the considerable interest, focused, particularly, on oxygen enrichment. Amongst the points which arose were:—(1) That a heavy metal stream is best in soda-ash desulphurisation and that some phosphorus removal can be effected in a basic-lined second ladle, with soda-ash and mill-scale (Mr. N. L. Evans, I.C.I., Alkali); (2) that the main trouble with oxygen enrichment of converter blast was the production of a very heavy, red fume (Mr. F. A. Martin); (3) that blowing time, with 40 per cent. enrichment, depended on initial temperature, mass and composition, from 3½ minutes on a small furnace with low-silicon metal to 30 to 40 minutes for 3 tons of metal with 1.7 per cent. Si (Mr. A. Catton); (4) that carbon as a refractory, though perhaps suitable in a blast furnace was of doubtful applicability for cupolas (various speakers), though rammed carbon was fairly cheap (Mr. A. G. Robiette) and (5) that the problem of oxygen supply from small plants was difficult; it really devolved upon possibilities of nitrogen extraction from air and this line was being pursued (Dr. P. M. Schufton, British Oxygen Company).

Electric-arc Process

The first Paper in the afternoon was by Mr. J. H. Pearce and Mr. W. Bramhall, of the English Steel Corporation, Limited, on the specialised control of the process. It was read by Mr. Pearce and related to methods at the Authors' works where both acid and basic furnaces for ordinary carbon steels are operated. Adoption of the "acid" process was said to be increasing in this country and in the United States five times as much steel for castings was produced in acid furnaces as in other furnaces. Details of the working of an "acid" charge were then quoted, starting with 50 per cent. returns, 42 per cent. turnings (low S and P), and 8 per cent. high-carbon pig. This was melted down quickly (2 tons in 50 minutes.) and ore was added for a rapid "boil" down to 0.04 C. below the final percentage required. Lime chippings were added to thin the slag if required. Final additions of ferro-manganese were made and tests were taken and aluminium was added in the ladle, 2 lb. per ton being considered a suitable amount. Similar details were then quoted for "basic" operation. Materials were less critical for this furnace, as both sulphur and phosphorus were removed by the two-slag process which was worked. Advantages reported for the "acid" process were lower refractory cost and longer life between brickings, lower power consumption per ton; higher tonnage output from a given unit, because it was a faster process and a more fluid steel for the castings.

Refractories

Dr. J. R. Rait, of Hadfields Limited, next presented a Paper on electric-furnace refractories; he reported on experiments in progress on roof refractories and on the relative popularity of "acid," "basic" and "neutral" refractories for different furnaces. Silica bricks were finding most favour for the whole of "acid"-furnace linings and also for the roofs of "basic" furnaces, they were load-sustaining at high temperature and resisted FeO attack. It was important that their alumina content should be as low as possible. Substitutes, such as silimanite, andalusite and chrome-magnesite, were much more expensive. For the hearths of "basic" furnaces, rammed calcined dolomite found most favour.

In the discussion which followed on these two Papers, questions were asked, initially, about the relative properties of "acid" and "basic" steels; it being disclosed that "acid" steel was better for green-sand castings, while "basic" steel had a better ductility due to its lower S and P contents. Acid refractories worked out at several shillings per ton cheaper than basic and about 70 units of electricity per ton were saved on "acid" melting. The Chairman (Mr. Lamb) quoted an overall figure of 10s. per ton cheaper for the "acid" steel.

Questions were raised in the discussion of Mr. Rait's Paper about the purpose of nail reinforcement in basic refractories, and varying opinions were put forward. Dr. A. H. B. Cross (Thos. Firth & John Brown, Limited) reiterated need for low-alumina and low-porosity silica bricks, and Mr. Brampton (General Refractories Limited) said these points were being specially watched. The last speaker also asked what was general experience with chrome pick-up from chrome-magnesite bricks, but the opinion of the meeting disclosed that little trouble was found except when a brick fell into a slag-free bath after refining.

Electric-furnace Design

A very informative Paper by Mr. J. C. Howard (Electric Furnace Company, Limited) followed. It dealt with the electrical characteristics, output and design of electric furnaces. Little radical change was reported on the original Heroult design, but there was some structural improvement on the furnace and major developments in the electrical equipment in the direction of securing reduced maintenance. Details were quoted of transformer circuit-breaker and voltage-regulator designs. In discussion it was stated that close-together electrodes were best, but standardisation was urged, particularly for holes and special-brick shapes. Lower electrode consumption was reported for the use of smaller-than-standard electrodes, a change from 12 to 10-in. in dia. in one case had saved 2-lb. per ton of steel on electrodes. This tendency was confirmed by Mr. H. Cawley, of British Acheson Electrodes, Limited.

Open-hearth Practice

The case of an open-hearth plant, which made steel both for associated rolling mills and castings for outside sale, was next put forward by Mr. J. Mowat, of William Beardmore & Company, Limited. In the United States this type of plant was said to be producing more steel for castings than the total output from all types in this country. Most plants here on basic open-hearth steel are so busy producing ingots for rolling that they have no capacity for castings. Acid open-hearth plants are good steel producers but 24-hr. operation really is necessary, and large quantities at infrequent intervals are the main deterrent for the smaller castings. Where some of the steel can be used for ingots, open-hearth steel can be produced also for castings at a 15 per cent. saving on "electric" steel. For large, 30-ton or over, castings, the open-hearth is the most economical production unit. Finally, the Author quoted comparative average test figures for seventeen jobs made in both "basic"-electric and "acid" open-hearth as follows:—

	U.T.S. tons per sq. in.	Elongation.
Basic electric ...	32.7	30.6
Acid open-hearth ...	31.7	31.7

During the discussion on this Paper it was made clear that the "acid" open-hearth process gave ample time for a long boil, *e.g.*, carbon from 1.0 to 0.25 per cent. spread over 4 hrs., that 30 to 50 per cent. of the charge was pig iron, as compared with five per cent. in the "basic" electric furnace and that at this works no casting less than 10 tons in weight was poured.

Productivity

The climax of the day's proceedings was reached in the final Paper. This was the scathing indictment of British steelfounding productivity compared with that in the United States, and was delivered in calm, matter-of-fact yet bitingly incisive tones by Mr. F. A. Martin, who had led the productivity team of steelfounders to America earlier this year. The following features of American production were quoted as indicative of the state of affairs:—(1) Melting cycles were from one hour in the U.S., whereas ours are 4 hrs. upwards on comparative furnaces, one reason being the use in America of power ratings of double ours; (2) better electrode control gave a lower power consumption per ton; (3) the use of the oxygen lance for promoting the boil; (4) "acid"-lined furnaces are paramount; (5) mechanised furnace charging is universal in the States; (6) labour is used with the utmost economy and we in this country lag a long way behind with labour-saving devices—our manning has shown no reduction in 30 years. The Author quoted the personnel in one American plant of three furnaces as consisting of one melter, two assistants and three "scrap" men to produce a melt in each furnace per hour and yet no-one seemed overworked. Physique was no different and the proportion of skilled men was smaller in America. There seemed to be a highly competitive spirit and desire among Americans to improve themselves which we lack.

The Author concluded by exhorting the company to get productivity minded, to try out improvements, to use, for example, the oxygen lance, and above all to get rid of complacency—it was, he said, the only way, if we had red blood in our veins, to show that we could take up the challenge. With these stirring remarks as food for thought, the Conference adjourned until next day.

SESSION II

Foreign Steel Melting Practice

For this session Mr. W. H. Everard (Edgar Allen & Company, Limited) was in the chair. It was fitting that Mr. F. A. Martin's exhortations of the previous evening should be followed on the Friday morning by the factual Paper by Mr. A. C. Brearley, of K. & L. Steelfounders & Engineers, Limited, on foreign steel-melting practice. It was delivered in a convincingly enthusiastic manner, which communicated itself to the audience. Beginning with a brief review of German practice as gleaned from the published reports of post-war investigators, the Author followed with a first-hand detailed account of acid-electric melting practice in the United States. Figures quoted for transformer capacities were 400 to 700 k.v.a. per long ton, to give melts of 45 to 75 mins. duration in furnaces holding three to seven tons. Sometimes, furnace bottoms were of rammed ganister with a 6-in. layer of silica sand and gave a life of three to four years. The rest of the furnace was silica-brick lined, life for this varied greatly from 14 days or 100 heats on one plant to six weeks or 300 heats on another. Turnings were largely vetoed for the charge which was strictly standardised, as was the detail of working; scrap segregation, especially, was well looked after. Fracture samples were mainly relied upon for determining the conditions and much reliance was placed on the skill of the melter.

Oxygen Lance

In many cases, an oxygen lance, consisting of a refractory-coated 4-ft. length of ½- or ¾-in. dia. steel

Steel Melting for Foundries

tube was used instead of "ore-ing" down to produce the "boil." The bath was left hot and slightly boiling after melting and oxygen at 60 to 80 lb. per sq. in. pressure was introduced, after removing the electrodes, and was moved about the bath for 2½ to 3 mins., to reduce 0.30 to 0.40 per cent. carbon down to 0.15 to 0.18 per cent. Oxygen was used at the rate of 120 cub. ft. per long ton and current consumption on the furnace was reduced by 30 to 60 kw.-hr. per ton. Two plants had reported an over-all economy with the oxygen lance on materials alone, in addition to a saving of 7 to 20 mins. on melt time as compared with the "ore" process. Refractory wear was said to be unaffected.

On refining processes in America, there seemed to be wide divergency in practice, proprietary compounds being much used. No immersion processes were used for temperature measurement and relatively little use was made of chemical analyses during the melt. The Author concluded by recounting special features of American practice for alloy-steel production and finally stressed that "good enough for its job" was the main quality criterion as distinct from subservience to high figures.

Then followed a lengthy discussion on Mr. F. A. Martin's Paper of the previous evening. It centred round the U.S. price for electricity—said to be comparable with ours, the significant part played by the "fear" element on American competitive spirit, the lack of social security there, which would intensify fear of unemployment, the American ability to finalise a standard process or job, all of which combined to make up the "state of mind" in which all grades of Americans worked together to secure so great a measure of productivity. Mr. Brearley's Paper was discussed consecutively and numerous points of detail were added by various speakers to complete the picture of American melting practice.

High-frequency Melting

Two contributions were presented on the subject of high-frequency steel melting. The first was by Mr. C. McNair, of Hadfields, Limited, and in it operational and economic aspects of this unit were described. The simplicity and flexibility of the process were emphasised, one-ton-per-hour output from small units being secured with close temperature control, conservation of alloys, low cost of refractories and reduced power consumption per ton compared with arc furnaces. Disadvantages were that no refining was possible and there were practical limitations on the size of plant and the electrical accessories. At the works of the Author the H.F. plant was used for producing special steels in small quantities or to supplement arc-furnace tonnage.

The second contribution on this subject was an impromptu account by Mr. J. C. Howard on the design of H.F. furnaces and equipment. Considerations governing the selection of operating frequency were outlined and the advantages of motor-generators for power supply were stressed. Mr. Howard confirmed the favourable features of the H.F. process quoted by the previous speaker, but added that capital costs for these furnaces were 50 to 75 per cent. higher than for equivalent arc-furnaces; no electrodes were consumed, however, and refractory consumption was low, rammed monolithic linings being used. The use of spare wound furnace bodies, each about 10 to 15 per cent. of the original capital cost, was put forward as a worthwhile investment.

The discussion on high-frequency furnaces was on a very practical level. The circulation effect was touched on by several speakers and mention was made of separate H.F. additions to the arc furnace for securing this effect. In reply to a question from Mr. P. C. Fassotte, it was stated that there was no reason why oxygen should not be used to produce a "boil" in high-frequency furnaces and refining could thus be effected. The attachment of a high-frequency superheater to a cupola or forehearth was said to entail constructional difficulties as well as high capital costs. In reply to a question from Dr. Newell, Mr. Howard said a 10- or 12-ton high-frequency furnace was now practicable, and Mr. Robiette added that a 12-ton furnace was operating in Italy.

Fluidity

The opening Paper of the Friday afternoon session of the Conference was by Mr. J. E. Worthington (B.I.S.R.A.) on the fluidity of different steels. This was in the nature of a progress report on work to date illustrated by slides. The fluidity-spiral test of Taylor, Rominski and Briggs with the addition of a constant-speed pouring device had been used to produce more consistent data on fluidity of carbon and alloy steels and interim results were quoted. The observation that, relatively speaking, acid side-blown converter steel has more "life" in the foundry than that made by other processes was thought to be due to a critical FeO content for this steel. An, as yet, inexplicable point of inflexion was found on all the graphs drawn for fluidity against temperature, a point which had not been noticed in the more erratic results previously reported. The short discussion on the Paper attempted to relate "fluidity" with reproduction of pattern contour, but no decision could be arrived at.

Process Costs in Steel Melting

An attempt to correlate the costs of three processes of steel making—side-blown converter, "acid" electric and "basic" electric—was made by Mr. F. N. Lloyd (F. H. Lloyd & Company, Limited) in the closing Paper of the Conference. In his introductory remarks, Mr. Lloyd mentioned that ultimate cost was the amount of money dispersed to make a ton of steel and was an "absolute" figure. For "oncosts" or "overheads" he thought that the answer to the question "can this item be done without?" decided whether or no it was relevant to the issue. His company, which made steel by all three processes, was not able yet to give definite answer as to how best to produce liquid steel, there were too many individual variables, full effect of which could not be computed on a straight money basis. Twelve items of cost common to the three processes were listed and each was considered in detail as to its

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National Foundry College

Inauguration Ceremony

The third session of the National Foundry College was formally inaugurated, last Friday, at the Wolverhampton and Staffordshire Technical College. Earlier the same day, the Minister of Education, Mr. George Tomlinson, had informally opened the new students' hostel at Tor Lodge, Tettenhall Wood, near Wolverhampton.

The head of the Foundry College, Mr. J. Bamford, B.Sc., presented his report. He said that the National Foundry College opened in January, 1948. Its first task was to offer a single-session post-graduate full-time diploma course corresponding to the diploma course of the former British Foundry School. That was 20 months ago, and in that period two such diploma courses had been completed. In the early months of 1948 discussions took place concerning the type of course which would best suit the foundry industry, and it was decided that a two-part course should be adopted, the second part of which would approximate to the former one-year course. Part I was to be of six months' duration, commencing in September of each year, and continuing until March of the following year, followed by six months for renewed industrial experience. Part II was also to commence in September of each year, but was to continue until July of the following year.

This scheme made it possible for students deficient in certain ancillary subjects to receive additional training in these during the Part I course. Candidates exceptionally qualified both technically and industrially were admitted directly to Part II. Preparations were not sufficiently advanced to commence the first Part I course in September, 1948, but it was decided that it should open in January, 1949, rather than wait until the following September. Those who successfully completed this first Part I course were now in attendance as students in the final year.

The Students

The total number of students in the first session was 18, in the second session also 18, and in the third, the current session, almost 30. This figure was still well below the number it was hoped to enrol in future years. In respect of the first college session six students were awarded the Diploma of the National Foundry College, a similar high proportion of students being successful during the second session. Their awards awaited confirmation at a diploma board meeting to be held on October 12. About a quarter of the total number of students so far enrolled were from overseas—from Ceylon, China, Egypt, India, Iraq, Norway, South Africa and Switzerland. Of those students from the United Kingdom about half were sponsored by their employers.

In addition to its full-time courses, the National Foundry College was responsible for the foundry practice and pattern-making courses of the Wolverhampton and Staffordshire Technical College. It was hoped in the near future to be able to admit one or two of the students from these courses per year into the Part I diploma course at the National Foundry College.

The staff of the college was now at full strength. Mr. J. B. McIntyre was appointed as senior assistant, and took up duty in April, 1948, Mr. W. Prentice in January, 1949, and Mr. S. N. Wrightson in September, 1949.

During the last Session the college hostel, Tor Lodge, became available and 10 students took up residence after the Easter vacation. Accommodation was provided for a total of 26 students, and the hostel had a full and part-time staff of six. Mr. J. B. McIntyre acted as warden.

In July last the first and second sessions' students joined the old students of the pre-war British Foundry School in their old Students' Association—the Foundry Technical Group. This association was very much alive, and it was hoped that as membership increased it would become an important body in the industry.

National Certificates

The chairman, Mr. Randall G. Hosking, C.B.E. (chairman of the governors of the College) introduced the Minister of Education, who, in the course of his address, referred to the award of national certificates, and said it was 28 years since this type of course was introduced. It was a technicians' course—one which encouraged the apprentice to aim high. Its standing was assured, for it called for great perseverance and ability on the part of the students over three or five years' of study. In 1939 the number of certificates awarded was 4,000; in 1948 there were 8,000—exactly double. The Higher National Certificate, which led to professional status, and was in a limited way equal to a degree, rose in number from 1,331 in 1939 to 4,519 in 1948. As one of the conditions of entry to this National College was the possession of a degree of Higher National Certificate, this development of national certificates would be of interest.

Dr. J. G. Pearce, in proposing a vote of thanks to the Minister, said much doubt had been expressed as to whether we were receiving value for money in education to-day, but in so far as he was entitled to speak, this was a point on which he had no doubt whatever. Before coming to the reason for this he suggested reflection on the size and importance of the foundry industry, which was basic to any industrial civilisation. This was obscured to the public because it was in large part a service industry, its products going, with other materials, into engineering assemblies like power plants and engines. Products which did go direct to the public, like pipes, baths, grates and stoves, were often disguised by ornamental or technical finishes. If his figures were rather rounded, it was because he lacked the necessary statistical details for non-ferrous castings, but the foundry industry produced between three and four million tons of castings a year, with a turnover of 150 to 200 million sterling. It employed some 200,000 workers and sustained from 1 to 2 per cent. of the country's population.

(*Continued on page* 29.)

Company News

The paragraphs below have been extracted from statements circulated to shareholders, speeches made at annual meetings, and other announcements.

Davy & United Engineering Company, Limited (MR. D. F. CAMPBELL):—The order-book continues at a high level, several important new contracts having been entrusted to the company. Output during the year increased, the sales value of production being about 22 per cent. higher than in the previous year; and good progress has been made with the scheme of re-equipment and development. The company now has a team of engineering designers which is second to none in the field of metal works' plant. In this respect much is owed to the American associates, United Engineering & Foundry Company, with whom the agreement has been extended for a further period. Export trade has been on a modest scale owing to the insistent demand at home for Davy-United equipment by metal-working companies who are themselves important exporters. Contact, however, is being maintained with many old customers abroad, who offer a prospective market for the future when the shackles of present monetary and other restrictions are loosed. The board set out 12 years ago to establish a modern and efficient organisation to serve particularly the iron, steel, and non-ferrous industries at home and abroad. During that period a keen and efficient staff has been formed and works capable of meeting the requirements of our metallurgical industries have been established by modernising and extending the capacity of the company's own works and by the purchase of additional properties in Middlesbrough and Glasgow. This policy has proved to have been fully justified by the prospective demand and present record total of unfilled orders. The process of reorganisation was not helped by the period of the war and consequent high taxation, but the following figures give some indication of the progress which has been made:—The fixed assets, which in 1936 totalled £149,096, now total £1,007,046, and in the meantime about £400,000 has been written off for depreciation; net liquid assets were £164,096 and they are now £619,547; capital was £290,737 and is now £941,250; stockholders' reserves were £22,706, as compared with £650,708 to-day.

Bentley Engineering Company, Limited, Leicester:—An extra-ordinary meeting is to be held on October 11 to consider the capitalisation of £273,835 share premium account and £46,165 from capital reserve for a free distribution of 1,600,000 4s. ordinary shares in the proportion of four for every one held on September 30. The authorised capital of the company is to be raised to £1,570,000 by the creation of 270,000 6 per cent. £1 cumulative preference shares and 3,600,000 4s. ordinary. The company is inviting the "remaining" ordinary shareholders of Wildt & Company, Limited, hosiery-machinery builders, of Leicester—previously Bentley Engineering had bought 241,000 out of the 480,000 issued ordinary 5s. shares of Wildt & Company—to exchange their shares for Bentley Engineering ordinary. The offer is now made of 25 ordinary shares of 4s. in Bentley Engineering for every four ordinary shares of 5s. in Wildt & Company. The consent of the Capital Issues Committee has been obtained. In the preliminary announcement of the merger it was stated that Bentley Engineering would offer five ordinary for every four ordinary in Wildt & Company.

Electric Furnace Company, Limited (MR. D. F. CAMPBELL):—The output of the company and its subsidiary, the Electric Resistance Furnace Company, Limited, has been at a high level, and the orders received are almost equal to the record figures of the war period. Trading conditions have been difficult in export markets, owing to the restriction of imports in South American markets and the completion of post-war reconstruction schemes in some European countries. In spite of this, the company has been remarkably successful in obtaining export trade, which constitutes 35 per cent. of the orders received. The export annual target allotted to the company for a 12-monthly period was exceeded in the first nine months of the financial year. One serious obstacle at present is the slow delivery of electrical equipment. Continental competition will undoubtedly increase, and British engineers, with inadequate power supplies and machine tools, and a short working week, will have difficulty in competing with Continental countries or with the Americans.

Aluminium Castings Company, Limited (MR. R. K. CALDER):—Certain units of the group earned "satisfactory and substantial" profits, but these were more than offset by losses of those units catering primarily for the domestic consumer goods market. Of borrowing of £300,000 sanctioned by the C.I.C., £200,000 had been drawn at the date of the accounts and a further £25,000 has been drawn since. The remaining balance will be drawn in the near future to reduce the bank overdraft. The directors are aware of the need to replace these loan facilities by permanent finance, "and the earliest favourable opportunity will be taken to consolidate the position." Group turnover is up in the year to date by over 15 per cent, and trading results show "considerable improvement."

Foundry Equipment, Limited

Some 80 guests were entertained to luncheon on Friday last at the Swan Hotel, Leighton Buzzard, by the chairman and directors of Foundry Equipment, Limited. The occasion was the opening of a new office block at Linslade Works by Sir Geoffrey Clarke, C.S.I., O.B.E. Following the luncheon, Sir Geoffrey proposed the toast of Foundry Equipment, Limited. He referred to the obvious signs of enterprise and comradeship so evident during his visit to the works that morning, and expressed the hope that the firm would continue to progress and prosper unhindered by the political clouds that so sadly overshadowed the industrial scene. Mr. A. S. Beech, the chairman, replying, thanked Sir Geoffrey warmly for his visit. He recalled the firm's beginnings in 1932 and stressed the rapid advancement that the last 17 years had seen; their products were now being exported to a great number of overseas foundries, and at home the company's progress was no less marked.

Company Results

(Figures for previous year in brackets.)

ALBRIGHT & WILSON—Interim dividend of 10% (same).

VICKERS—Interim dividend of 2% (4%) on doubled capital.

QUALCAST—Final dividend of 45% (40%), making 65% (60%).

THOMAS BOLTON & SONS—Interim dividend of 2½% (same).

HANDLEY PAGE—Interim dividend of 10%, less tax (5%, tax free).

STOTHERT & PITT—Dividend of 15% (dividend of 10% and bonus of 5%).

C. A. PARSONS & COMPANY—Interim dividend of 5% (same) and jubilee bonus of 2½% (nil).

CHESWICK & WRIGHT—First and final dividend of 40% (final dividend of 40%, making 80%).

CROFTS ENGINEERS (HOLDINGS)—Interim dividend of 15%. The company was registered last November.

MIDLAND IRON & HARDWARE COMPANY (CRADLEY HEATH), LIMITED, increased by £269,000, in 300,000 5 per cent. cumulative preference shares of 10s. and 2,380,000 ordinary shares of 1s. each, beyond the registered capital of £31,000.

COWANS, SHELDON & COMPANY—Trading profit for the year to June 30, plus other income, £47,264 (£80,682); to tax, £19,000 (£22,225); directors' emoluments, £9,098 (£12,770), etc.; net profit, £12,578 (£32,310); dividend of 15% (same); general reserve, nil (£17,500); forward, £65,038 (£64,835).

LINLEY ENGINEERING COMPANY—Profit to March 31, £7,704 (£8,803); brought in, £6,460 (£5,403); tax over-reserved previous year, £17 (£991); available, £14,181 (£15,197); dividend of 10% (same); to deferred maintenance reserve, nil (£3,000); profits-tax reserve, £1,100 (same); income-tax reserve, £3,000 (£3,400); forward, £6,843.

SMITH, PATTERSON & COMPANY—Consolidated trading profit for the year ended June 30, plus sundry income and unrequired tax provision, £162,176 (£129,522); to depreciation, £3,450 (£3,378); interest, nil (£33); directors' fees, £1,080 (same); auditors' remuneration, £405 (£425); capital issue expenses, nil (£754); tax, £80,372 (£66,959); general reserve, £60,800 (£40,470); dividend of 25% (same); forward, £8,145 (£7,889).

RICHARDS BROS. & SONS—Trading profit for the year ended April 30, £96,145 (£89,509); to depreciation, £7,937 (£4,102); directors' remuneration, £5,788 (£5,640); auditors' remuneration, £240 (same); taxation, £39,900 (£36,635); net profit, £42,280 (£42,892); to reserve for future income tax, £20,000 (nil); preference dividend, £3,437 (£2,292); final ordinary dividend of 15%, making 25% (same); forward, £33,486 (£32,519).

BRIGHTSIDE FOUNDRY & ENGINEERING COMPANY—Consolidated trading profit to June 30, £353,296 (£276,241); other income—including investment reserve not now required £507 (profit on sale of investments £483)—£1,415 (£953); to depreciation, £42,441 (£40,519); audit fees, etc., £809 (£797); expenses sub-let properties, less rents, £26 (£191); patent fees, £111 (£210); profits tax, £48,619 (£41,468); income tax, £104,998 (£87,682); net profit, £157,707 (£106,327); parent company's net profit, £132,872 (£85,429); dividend of 50% (same including bonus of 15%); general reserve, £25,000 (£10,119); plant replacement reserve, £25,000 (same); forward, £132,870 (£106,373).

ZINC CORPORATION—Gross revenue from products for 1948, £5,777,236 (£4,847,913); interest and dividends, £56,475 (£31,589); to mining, milling, smelting, etc., expenses, £3,049,095 (£2,402,477); development, £394,839 (£323,024); administration, £112,639 (£102,014); depreciation and appropriation for new plant and shaft sinking, £83,947 (£153,099); pensions, £235,540 (£150,000); net profit, £1,957,651 (£1,748,888); to taxation, £1,046,300 (£926,098); royalty, £437,564 (£363,587); dividends (net), £472,469 (£331,270); increase in carry-forward, £1,318 (£7,933); final dividend of 7s. 6d., making 10s. on increased capital; forward, £240,092 (£144,909). Since the end of the year the issued capital of the Corporation has been acquired by Consolidated Zinc Corporation, Limited.

BENTLEY ENGINEERING COMPANY—Group trading profit for 1948, £294,610 (£127,709); to depreciation, £46,800 (£36,018); William Cotton trading loss, £18,253 (£52,038); depreciation, £20,344 (£6,784); profit, £209,213 (£32,869); profit from valuation of stocks and work, nil (£15,353); profit attributable to previous periods, nil (£11,893); surplus provisions, £9,691 (£20,000); interest, etc., £3,611 (£8,342); profits tax, £35,467 (£11,436); income tax, £107,231 (£50,718); "other" income tax, £1,594 (£1,434); consolidated net profit, £78,223 (£24,869); off goodwill by subsidiary, £150 (nil); dividends (net) by Bentley Engineering, £35,546 (£32,874); forward, £118,581 (£76,147); Bentley Engineering's ordinary dividend is 40% (same).

ALUMINIUM CASTINGS COMPANY—Consolidated trading profit to March 31, £34,383 (£97,110); interest, £18 (£165); gains on realisation of assets, £1,513 (nil); to audit, £1,080 (£978); depreciation, £23,875 (£22,003); directors' remuneration, £5,946 (£8,700); loan and bank interest, £9,935 (£5,228); taxation, £10,181 (£34,106); loss, £15,103 (profit £26,269); allowances no longer required, £1,872 (£1,500); tax adjustments for previous years, £11,012 (£28,585); brought in, £31,657 (£29,092); balance available, £29,438 (£85,446); transfer to capital reserve, nil (£37,207); intangible assets written off, £1,932 (£4,442); transfer from war damage account, £1,717 (nil); leaving £29,223 (£43,797); preference dividend, £4,950 (£4,575); preferred ordinary dividend, nil (11¼%); ordinary dividend, nil (20%); forward, £24,273 (£31,659).

ELECTRIC FURNACE COMPANY—Consolidated trading profit for the year to March 31, £49,711 (£51,473); dividends and interest, £2,725 (£3,566); to directors' emoluments, holding company, £16,537 (£18,940); bank and loan interest and charges, £5,937 (£5,383); audit, £603 (£604); depreciation, £6,704 (£4,237); profit, £22,655 (£25,875); to taxation, £14,460 (£14,700); leaving £8,195 (£11,175) (to which was added previously £945 provisions no longer required and £1,589 patent fees recoverable in respect of earlier years, making £13,709); to bomb damage expenditure now written off as irrecoverable and less estimated tax allowance, £677 (nil); provision for depreciation of quoted investments, nil (£600); deferred repairs, nil (£2,000); preferred ordinary dividend of 8% (same); ordinary dividend of 8% (same); forward, £13,638 (£13,325).

DOWSETT HOLDINGS—Consolidated profits for the year to March 31, after all expenses and depreciation, £118,337 (£105,491); to initial depreciation allowances on capital expenditure, £35,549 (£15,338); taxation, including income tax and profits tax, less excess provision for previous years, £30,882 (£36,687); net profit, £51,906 (£53,466); dividends payable to Dowsett Partnership (net), £2,623 (£3,135), of which the dividend on 2,375 shares is receivable by Dowsett Holdings £955 (£1,534); to net balance, £50,238 (£51,865); brought in, £50,768 (£20,597); balance of initial depreciation allowances on plant, etc., in respect of three previous years ended March 31, 1947, nil (£13,526); dividend on the 5½% redeemable preference shares, £8,168 (same), dividend (maiden) on ordinary of 10%, £8,910 (nil); to preference sinking fund, £7,290 (nil); forward: Dowsett Holdings £8,529 (£7,411), subsidiaries £68,109 (£43,357).

Steel Melting for Foundries

(*Continued from page* 414)

contribution to the total. Discussion elucidated the fact that it was easier to lose more money if a foundry waited or was inconvenienced than it was on direct melting cost, so that the ultimate ruling should be in favour of suitability and flexibility to meet production requirements.

At the end of the proceedings, Dr. Newell briefly summed up and thanked Mr. Lamb and Mr. Everard for so ably taking the chair for the respective sessions. The Authors who had so kindly made available so many facts and figures, the speakers from the body of the hall, and the whole of the delegates who had attended and taken part in informal conversations, had, he said, contributed much of value to the whole steel founding industry. There had been an atmosphere of unusual frankness and infectious enthusiasm perhaps never before realised in conferences of this sort.

Raw Material Markets

Iron and Steel

Outputs of all grades of foundry pig-iron and hematite are generally sufficient for current demands, and in the case of high-phosphorus iron for the light foundries and low- and medium-phosphorus iron for the engineering foundries supplies can usually be obtained to the analyses required. Hematite, however, is mostly in the lower percentage of silicon, and this constituent can rarely be obtained above 3 per cent. Another furnace now in production in the Derbyshire area has provided additional supplies of high-phosphorus pig-iron, but the overall output leaves no appreciable quantity for stock at either the furnaces or the foundries after current usage is satisfied. The refined grades can mostly be secured to consumers' requirements.

Foundry coke supplies are satisfactory and are being delivered in allocated quantities. Quality and size have generally shown some improvement, although a few complaints are still being made in regard to size. Furnace coke for heating and core-oven requirements is in good supply. Limestone, ganister, and ferro-alloys are coming forward in the required quantities, and firebricks can be obtained provided sufficient notice is given for delivery. The scrap position continues to be easier, but parcels of suitable cupola scrap in cast iron and steel are readily accepted.

The impact of devaluation on the trade in steel semis has been the subject of anxious speculation in the re-rolling industry. The activity of this branch of the steel industry is largely sustained by imports of blooms, billets, and sheet bars from Belgium, Luxemburg, and France, and it follows that if these countries endeavour to avoid any variation in their currency values, the market in this country for steel semis may be jeopardised. Possibly, the situation will be quickly clarified and, in the meantime, there are good working stocks at the mills. Consumption of sheet bars and slabs is, however, very heavy and it is hoped that any interruption in the intake of foreign material will be brief.

British steelworks are in good shape to take part in the intensified export drive, which is the outstanding feature of the Government's economic programme. There is still a very extensive overseas demand for all classes of finished steel products (with the possible exception of small bars and light sections) and steel consumers engaged principally in production for overseas markets are expecting more liberal allocations of steel. If price inflation can be avoided, there is every prospect of full employment for the rolling mills. Demand for plates and sheets is heavy and big orders are in hand for steel rails.

Non-ferrous Metals

Sales of copper, lead, zinc, and aluminium by the Ministry of Supply were resumed last Thursday at the new prices introduced following the devaluation of the pound. A statement on tin, however, was delayed until Monday morning, when it was announced that bulk-buying of Empire tin by the Ministry of Supply is to end as soon as alternative marketing arrangements can be made through the London Metal Exchange. It is expected also that the Singapore market will reopen. Meanwhile, the Ministry will make tin available to domestic and foreign buyers.

The new selling price to United Kingdom buyers is £750 per ton for tin of minimum 99 per cent. and less than 99.7 per cent. tin content, which compares with the previous figure of £569. The price to U.S. consumers will be reduced from the former $1.03 per lb. to 95 cents, equal in sterling to £739 a ton ex smelter at Penang or Singapore.

The Ministry of Supply stated that discussions are in progress between the Government and the Committee of the London Metal Exchange with a view to re-opening the Exchange for dealings in tin at the earliest possible practicable date, and determination of the conditions in which it will operate.

It is felt that with tin at its new price the prospects for exporting tinplate will be gravely endangered. In fact, it is already obvious that, so far as the non-ferrous metals are concerned, export trade is going to be difficult, and expansion almost out of the question. Had the Ministry evaluated its purchases from the sterling area at the pre-devaluation price, it might have been possible to reap some advantages from sales in the hard-currency areas, but in spite of the fact that copper at £140 is about £10 lower than 17¾ cents at $2.80, plus charges, justifies, it is still not as low as it would be were full credit given to the consumers for the country's large purchases from Northern Rhodesia. Grave doubts are felt about the effect of lead at £122, for it is remembered that the last time this metal rose to such a level, demand declined in a noticeable fashion.

On receipt of the news that virgin metal prices were fixed the scrap merchants re-entered the market, but they did not find the consumers particularly keen to buy on the basis of the revised values for old metals. Doubtless demand for scrap will revive, but it cannot be overlooked that the inflated levels now attained by non-ferrous metals are such as to discourage their use. Moreover, the question of financing purchases and stocks is a most difficult one which cannot fail to embarrass to some extent all interested parties. The extent of the increase is severe, and users of copper "shapes" (billets, cakes, etc.), are further penalised by the manner in which extras for these units have been raised, in some cases by as much as about 60 per cent.

OWING TO the vagaries of printing, we were unable to delete the decoration of M.C. which we inadvertently accorded to Col. Scott, on page 392 of this issue. We sincerely apologise for any embarrassment we may thereby have caused.

THE OFFICES of the Professional Engineers Appointments Bureau have been moved from 13 to 9, Victoria Street, Westminster, London, S.W.1.

STANTON-DALE

REFINED PIG IRON

Designed to meet the demands of high quality castings, which are, strength, machineability, and resistance to wear.

All these can be secured by using Stanton-Dale Refined Pig Iron in your cupolas.

The above illustration shows a group of castings made by Messrs. Goodbrand & Co. Ltd., Stalybridge, Cheshire.

PROMPT DELIVERY

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Imports and Exports of Iron and Steel

The following tables, based on Board of Trade returns, give figures of imports and exports of iron and steel in August. Figures for the same month in 1947 and 1948 are given for purposes of comparison.

Total Exports of Iron and Steel.

Destination.	Month ended August 31.		
	1947.	1948.	1949.
	Tons.	Tons.	Tons.
Channel Islands	553	1,184	767
Gibraltar	255	100	162
Malta and Gozo	97	449	859
Cyprus	146	75	762
British West Africa	3,019	2,337	5,171
Union of South Africa	14,164	8,843	6,971
Northern Rhodesia	1,188	766	2,243
Southern Rhodesia	1,035	1,852	5,196
British East Africa	3,597	3,312	8,744
Mauritius	518	382	1,351
Bahrein, Koweit, Qatar, and Trucial Oman	3,448	1,888	1,536
India	6,304*	4,145	7,267
Pakistan		823	2,670
Malaya	3,214	2,179	4,130
Ceylon	881	1,473	2,328
North Borneo	340	143	222
Hongkong	1,152	2,495	1,855
Australia	4,186	3,998	18,459
New Zealand	3,403	3,794	7,191
Canada	1,370	921	4,128
Bermuda	6	93	89
British West Indies	1,396	2,981	4,390
British Guiana	274	310	364
Anglo-Egyptian Sudan	1,410	760	1,032
Other British countries	208	636	1,069
Irish Republic	4,597	4,640	5,358
Russia	887	—	28
Finland	3,804	6,843	6,613
Sweden	6,034	6,272	5,650
Norway	4,293	7,065	4,221
Iceland	1,110	615	782
Denmark	5,887	6,070	4,260
Poland	52	187	172
Germany	15	27	20
Netherlands	7,494	4,279	6,888
Belgium	1,249	678	780
France	847	1,845	3,733
Switzerland	1,293	1,028	466
Portugal	1,093	700	964
Spain	446	411	662
Italy	18	1,140	338
Hungary	140	171	80
Czechoslovakia	460	16	24
Greece	240	125	381
Turkey	138	344	2,031
Dutch East Indies	884	2,745	1,790
Dutch West India Islands	177	549	773
Belgian Congo	116	216	55
French W. and Eq. Africa	138	54	6
Portuguese East Africa	688	149	400
Canary Islands	116	886	47
Syria	159	72	281
Lebanon	317	657	990
Palestine (Israel)	1,942	466	556
Egypt	4,754	2,567	3,387
Morocco	1,143	63	23
Iraq	4,336	4,637	6,402
Iran	4,624	9,930	11,474
Burma	4,269	859	464
Siam (Thailand)	231	146	249
China	8,895	685	41
U.S.A.	929	1,296	116
Cuba	370	23	18
Colombia	395	817	130
Venezuela	1,803	4,497	4,784
Ecuador	109	183	2
Peru	453	290	122
Chile	383	303	665
Brazil	2,225	933	1,589
Uruguay	800	307	476
Argentine	7,552	9,229	6,820
Other foreign countries	2,034	2,498	2,923
Total	142,103	133,404	176,990

* Figures for 1947 relate to British India.

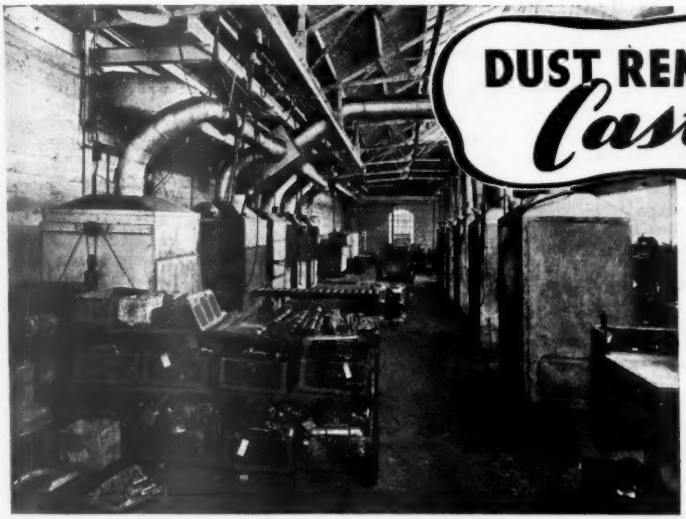
Total Imports of Iron and Steel.

From	Month ended August 31.		
	1947.	1948.	1949.
	Tons.	Tons.	Tons.
Australia	5,331	11	3,120
Canada	11,827	5,616	5,304
Other British countries and Irish Republic	803	83	9,078
Sweden	652	676	1,057
Norway	1,868	2,010	1,171
Germany	935	701	7,235
Netherlands	359	3,534	10,967
Belgium	6,069	10,785	18,704
Luxemburg	470	2,491	6,829
France	21	3,088	21,741
U.S.A.	6,446	6,863	40,919
Other foreign countries	1,478	133	868
Total	36,259	35,991	126,993
Iron ore and concentrates—			
Manganiferous	8,680	9,134	4,000
Other sorts	712,508	798,453	950,794
Iron and steel scrap and waste, fit only for the recovery of metal	10,186	68,593	244,065

Exports of Iron and Steel by Product.

Product.	Month ended August 31.		
	1947.	1948.	1949.
	Tons.	Tons.	Tons.
Pig-iron	3,169	54	1,095
Ferro-alloys, etc.—			
Ferro-tungsten	126	100	49
Spiegeleisen, ferro-manganese	294	76	900
All other descriptions	46	91	82
Ingots, blooms, billets and slabs	79	1,165	245
Iron bars and rods	280	410	462
Sheet and tinplate bars, wire rods	732	464	208
Bright steel bars	1,507	991	1,727
Other steel bars and rods	8,506	8,535	13,586
Special steel	1,398	1,354	1,286
Angles, shapes and sections	6,738	5,682	8,868
Castings and forgings	366	288	465
Girders, beams, joists, and pillars	1,160	1,160	2,189
Hoop and strip	2,561	3,267	5,090
Iron plate	19	321	907
Steel plate, ¼ in. thick and over	8,826	8,637	15,496
Do., under ¼ in. thick	6,145	6,040	9,466
Galvanised sheets	6,425	7,775	6,508
Tinplates	11,345	11,857	11,390
Tinned sheets	2,353	332	282
Terneplates	57	—	—
Decorated tinplates	—	53	9
Other coated plates	133	344	486
Cast-iron pipes, up to 6-in. dia.	4,360	5,250	6,095
Do., over 6-in. dia.	2,246	2,798	8,618
Wrought-iron tubes	17,499	24,217	24,167
Radiators, central-heating boilers	267	257	269
Railway material	11,150	9,908	11,913
Wire	3,352	2,463	4,279
Cable and rope	2,333	1,945	2,763
Netting, fencing and mesh	1,377	1,513	1,339
Other wire manufactures	593	799	948
Nails, tacks, studs, etc.	601	486	510
Rivets and washers	716	736	668
Wood screws	424	222	275
Bolts, nuts, and metal screws	1,737	1,811	1,975
Stoves, grates, etc. (excl. gas)	431	620	662
Do., gas	164	158	276
Sanitary cisterns	59	150	185
Baths, sinks, etc.	175	592	928
Fencing material	491	130	575
Anchors, etc.	776	682	685
Chains, etc.	759	771	861
Springs	308	373	545
Hollow-ware	6,058	3,181	6,813
All other manufactures*	23,902	15,346	20,845
Total	142,103	133,404	176,990

* Figures for 1949 are not completely comparable with those for previous years.



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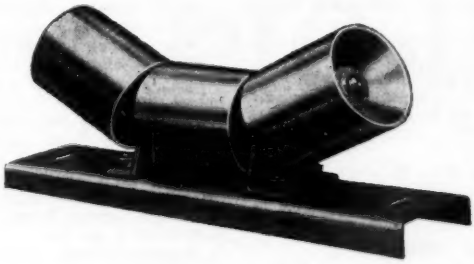

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(*Delivered, unless otherwise stated*)

September 28, 1949

PIG-IRON

Foundry Iron.—No. 3 IRON, CLASS 2:—Middlesbrough, £10 4s.; Birmingham, £10 0s. 6d.

Low-phosphorus Iron.—Over 0.10 to 0.75 per cent. P, £11 15s. 6d., delivered Birmingham. Staffordshire blast-furnace low-phosphorus foundry iron (0.10 to 0.50 per cent. P, up to 3 per cent. Si)—North Zone, £12 2s. 6d.; South Zone, £12 5s.

Scotch Iron.—No. 3 foundry, £11 18s. 3d., d/d Grangemouth.

Cylinder and Refined Irons.—North Zone, £12 14s. 6d.; South Zone, £12 17s.

Refined Malleable.—P, 0.10 per cent. max.—North Zone, £13 4s. 6d.; South Zone, £13 7s.

Cold Blast.—South Staffs, £15 16s. 6d.

Hematite.—Si up to 2½ per cent., S & P over 0.03 to 0.05 per cent.; N.-E. Coast and N.-W. Coast of England, £11 16s. 6d.; Scotland, £12 3s.; Sheffield, £12 9s.; Birmingham, £12 15s.; Wales (Welsh iron), £11 16s. 6d.

Spiegeleisen.—20 per cent. Mn, £17 8s.

Basic Pig-iron.—£9 17s. 6d., all districts.

FERRO-ALLOYS

(*Per ton unless otherwise stated, basis 2-ton lots, d/d Sheffield works.*)

Ferro-silicon (6-ton lots).—20/30 per cent., £25 15s.; 40/55 per cent., £32 10s.; 70/85 per cent., £49.

Ferro-vanadium.—35/50 per cent., 15s. per lb. of V.

Ferro-molybdenum.—70/75 per cent., carbon-free, 6s. 5d. per lb. of Mo.

Ferro-titanium.—20/25 per cent., carbon-free, 1s. 3½d. lb.

Ferro-tungsten.—80/85 per cent., 6s. 6d. lb.

Tungsten Metal Powder.—98/99 per cent., 7s. 6d. lb.

Ferro-chrome.—4/8 per cent. C, £60; max. 2 per cent. C, 1s. 5d. lb.; max. 1 per cent. C, 1s. 5½d. lb.; max. 0.15 per cent. C, 1s. 6¼d. lb.

Cobalt.—98/99 per cent., 12s. lb.

Metallic Chromium.—96/98 per cent., 5s. 1d. lb.

Ferro-manganese (blast-furnace).—78 per cent., £25 3s.

Metallic Manganese.—94/96 per cent., carbon-free, 1s. 9d. lb.

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms and Slabs.—BASIC: Soft, u.t.s. £16 16s. 6d.; tested, up to 0.25 per cent. C (100-ton lots), £17 1s. 6d.; hard (0.42 to 0.60 per cent. C), £18 16s. 6d.; silico-manganese, £23 19s.; free-cutting, £20 1s. 6d. SIEMENS MARTIN ACID: Up to 0.25 per cent. C, £22 4s.; case-hardening, £23 1s. 6d.; silico-manganese, £26 6s. 6d.

Billets, Blooms and Slabs for Forging and Stamping.—Basic, soft, up to 0.25 per cent. C, £19 16s. 6d.; basic, hard, over 0.41 up to 0.60 per cent. C, £21 1s. 6d.; acid, up to 0.25 per cent. C, £23 1s. 6d.

Sheet and Tinplate Bars.—£16 16s. 6d.

FINISHED STEEL

Heavy Plates and Sections.—Plates, ship (N.-E. Coast), £20 14s. 6d.; boiler plates (N.-E. Coast), £22 2s.; chequer plates (N.-E. Coast), £22 19s. 6d.; heavy joists, sections, and bars (angle basis), N.E. Coast, £19 13s. 6d.

Small Bars, Sheets, etc.—Rounds and squares, under 3 in., untested, £22 6s.; flats, 5 in. wide and under, £22 6s.; rails, heavy, f.o.t., £19 2s. 6d.; hoop and strip, £23 1s.; black sheets, 17/20 g., £28 16s.

Alloy Steel Bars.—1-in. dia. and up: Nickel, £35 6s. 6d.; nickel-chrome, £49 18s. 6d.; nickel-chrome-molybdenum, £55 0s. 9d.

Tinplates.—I.C. cokes, 20 × 14, per box, 41s. 6d., f.o.t. makers' works.

NON-FERROUS METALS

Copper.—Electrolytic, £140; high-grade fire-refined, £139 10s.; fire-refined of not less than 99.7 per cent., £139; ditto, 99.2 per cent., £138 10s.; black hot-rolled wire rods, £146.

Tin.—99 to under 99.75 per cent., £750; 99.75 to under 99.9 per cent., £757; min. 99.9 per cent., £760.

Zinc.—G.O.B. (foreign) (duty paid), £87 10s.; ditto (domestic), £87 10s.; "Prime Western," £87 10s.; electrolytic, £88 5s.; not less than 99.99 per cent., £89 15s.

Lead.—Good soft pig-lead (foreign) (duty paid), £122; ditto (Empire and domestic), £122.

Zinc Sheets, etc.—Sheets, 10g. and thicker, all English destinations £103 10s.; rolled zinc (boiler plates), all English destinations, £101 10s.; zinc oxide (Red Seal), d/d buyers' premises, —.

Other Metals.—Aluminium, ingots, £112; antimony, English, 99 per cent., —; quicksilver, ex warehouse, £26 5s.; nickel, £321 10s.

Brass.—Solid-drawn tubes, 23¼d. per lb.; rods, drawn, —; sheets to 10 w.g., —; wire, 19⅝d.; rolled metal, 17¾d.

Copper Tubes, etc.—Solid-drawn tubes, 23¼d. per lb.; wire, — per cwt. basis; 20 s.w.g., — per cwt.

Gunmetal (indications only).—Ingots to L.G.2 (85/5/5/5), £102; L.G.3 (86/7/5/2), £112; GI (88/10/2), £160 per ton, delivered.

Phosphor-bronze Ingots (inhications only).—P.Bl, £170; L.P.Bl, £114 per ton.

Phosphor Bronze.—Strip, — per lb.; sheets to 10 w.g., —; wire, —; rods, —; tubes, —; chill cast bars: solids, —, cored, — (C. CLIFFORD & SON, LIMITED.)

Nickel Silver, etc.—Ingots for raising, 1s. 8¼d. per lb. (7%) to 2s. 6¾d. (30%); rolled metal, 3 in. to 9 in. wide, × .056, 2s. 2¾d. (7%) to 3s. 0¾d. (30%); to 12 in. wide, × .056, 2s. 3d. to 3s. 1d.; to 25 in. wide, × .056, 2s. 5d. to 3s. 3d. Spoon and fork metal, unsheared, 2s. 1¼d. to 2s. 11¼d. Wire, 10g., in coil, 2s. 8d. (10%) to 3s. 6¼d. (30%). Special quality turning rod, 10%, 2s. 7d.; 15%, 2s. 11½d.; 18%, 3s. 3¼d.

National Foundry College

(*Continued from page* 415.)

Within a short span of 25 years the founding industry had changed from a purely craft industry, carried on in small and isolated establishments, to an integrated and highly technical industry, some establishments in which could not be matched in size and efficiency anywhere in the world. The Midlands was the centre of gravity of this industry. In the U.K. there were several thousand establishments—maybe 4,000—but being modest and saying that there were 500 significant establishments, that was, which required at least one trained individual. It was once held to be the peculiar glory of the Church of England that it put an educated man in every parish. Could the foundry industry not say that the National Foundry College should put a trained man in every significant foundry?

He did not mean that a man was not a good foundry manager or executive if he had not been there, but he must be better if he had. To accomplish this task in five years would mean at least 100 men a year, which would mean increasing the College in size some four or five times. English-fashion, reliance for students was placed on the nominations of far-sighted employers and on scholarship aids for those young men who were determined to get on and who saw in the College a means to this end. And how right they were. He had met two Americans prominently connected with the Anglo-American Productivity Council; one, in his 50's, said he never had a college education and that if he were in the U.S. to-day, and 23 years of age, he would not have a ghost of a chance without it. He declared, in fact, that he was the last of his generation who could get by without a college education.

Foundry Efficiency

Dr. Pearce said the British Cast Iron Research Association was setting up an operational research team to examine, analyse and advise foundries on productive efficiency. He had taken a step which he devoutly hoped his council would endorse, of offering a prize to ex-students of the College and its predecessor, for the best essay on "Foundry Efficiency, its Estimation and Improvement." The industry needed these young men from the College to promote and maintain the most efficient working. The only other institution of its kind in the world was the French Foundry High School in Paris, which he and his colleagues hoped to have an opportunity of seeing on behalf of the Ministry in the near future, but he hoped it would be a long time before we allowed entrants to the National Foundry College to be drawn overwhelmingly from the universities and graduate institutions of higher technical education, as the French were tending to do. He wished every young man who had the root of the matter in him to enjoy these facilities, irrespective of education and background.

The vote of thanks was seconded by Mr. W. G. Fossick, M.A., past-Master of the Worshipful Company of Founders.

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Central 1558

GLASGOW, C.2.
98, Hope Street,
Central 9969

NOTICE

Small Advertisements in this section of the Journal are accepted at the *prepaid* rate of 20 words for 5/- (minimum charge) and 2d. per word thereafter. Box number advertisements 2/- extra Instructions together with remittance must be received not later than first post on Wednesday for inclusion in Thursday's issue addressed to the Advertisement Manager, " Foundry Trade Journal," 49, Wellington St., London, W.C.2.

Situations advertised under this heading are available only to applicants excepted from the Control of Engagement Order, 1947, No. 2021.

SITUATION WANTED

FOUNDRY FOREMAN seeks position as same; full qualifications; medium general grey iron or aluminium foundry; not afraid of work; could train unskilled hands; Midlands.—Box 428, FOUNDRY TRADE JOURNAL.

SITUATIONS VACANT

AUSTRALIA.—Important Concern requires WORKS MANAGER, to handle Foundry and Sheet Metal Operations and Wet Process Vitreous Enamelling; must also have background of engineering knowledge; wide scope and prospects for suitable man; preferably not over 45 years of age.—Apply Box 432, FOUNDRY TRADE JOURNAL.

A VACANCY exists for a practical Man with extensive experience of Jobbing and Mechanised Foundries producing Grey and High Duty Irons, to take charge of customer representation; the duties would include preparation of layouts, estimates, and supervision over proto-type castings, and after-sales service to customers; also to act as liaison between the Companies Agents and generally be in charge of sales.—Reply full details of past experience, and salary required, to Box 410, FOUNDRY TRADE JOURNAL.

CASTING INSPECTOR required to act as Assistant to Chief Inspector for Foundry making Cylinder Castings in the Midland area.—Box 424, FOUNDRY TRADE JOURNAL.

MARKER-UP required for Foundry making Cylinder Castings in the Midland Area.—Box 426, FOUNDRY TRADE JOURNAL.

UNDER-FOREMAN required by progressive South of England foundry making high-grade stainless steel castinga. One with drive, initiative and ability to instruct. Interesting work. State experience briefly.—Box No. S.2995, Bensons, Kingsway Hall, London, W.C.2.

SITUATIONS VACANT—*Contd.*

CORE SHOP FOREMAN for Light Alloy Foundry in Midlands; experienced in Motor, Aero and General Engineering work.—Apply, stating age, experience and salary.—Box 390, FOUNDRY TRADE JOURNAL.

FOREMAN required by London Iron Foundry, to take full charge of production of medium and light jobbing work and machine moulding; about twenty moulders employed; must be familiar with piecework and bonus systems; strict disciplinarian required.—Replies, qualifications, salary required, in confidence, to Box 386, FOUNDRY TRADE JOURNAL.

FOUNDRY FOREMAN required for North Midlands Foundry; experience in floor moulding and grey and alloy iron castings up to 3 tons weight essential.—Reply, stating age, details of experience, and salary required, Box 420, FOUNDRY TRADE JOURNAL.

HEAD FOREMAN required for Iron and Steel Foundry; one able to assist Foundry Manager; must be experienced with machine and jobbing moulding and conversant with cupola control; foundry situate near Upminster, Essex.—Box 414, FOUNDRY TRADE JOURNAL.

WANTED
Works Manager/Chief Engineer

ENGINEER required, to take over responsibilities of Works Manager and Chief Engineer of modern medium-sized Foundry in Midlands; must have had sound engineering training and accustomed to plant maintenance; also experienced in production procedure; expert knowledge of foundry technique not essential; good salary and prospects.—Apply Box 416, FOUNDRY TRADE JOURNAL.

METALLURGIST required, of graduate standard, in Quality Control Department of Modern Steel Foundry, situated in South Yorkshire; preferably under 25 years of age.—Reply, stating age, education, experience, and salary required, to Box 436, FOUNDRY TRADE JOURNAL.

SALESMAN required for large Heavy Duty Iron Founders in the Midlands area, to work in London and the Southern area; applicants must be capable of reading drawings, and obtaining orders for repetition castings.—Replies, giving full details of career to date, to Box 376, FOUNDRY TRADE JOURNAL.

WORKS MANAGER required by large Australian Company; must have executive ability, knowledge of foundry and sheet metal work, and general engineering experience; knowledge enamelling an advantage; real possibilities advancement right man; salary £900-£1,200, depending on experience.—Apply, stating age, etc., METTERS, LTD., 74, High Street, Rickmansworth, Herts.

SITUATIONS VACANT—*Contd.*

APPLICATIONS are invited for position of METALLURGIST for Non-ferrous Metal Ingot makers; qualifications to include sound practical experience and technical knowledge in the melting and treatment of scrap and residues; the position, which carries an excellent salary, is one of responsibility, with scope for initiative, giving opportunity of advancement on initial remuneration.—Apply, giving details of qualifications, age, etc., to Box 440, FOUNDRY TRADE JOURNAL.

SENIOR METALLURGIST or CHEMIST required; to take charge of the Laboratories controlling a large foundry and enamelling plant of an old-established Company in the Midlands; applicants should have a specialised knowledge of light casting foundry work and enamels for sheet and cast-iron continuous enamelling; age 30-45, and possessing B.Sc., A.R.I.C., or similar qualification; the post, which carries an excellent salary, is permanent and pensionable.—Applications, which must be marked TR/19, should be sent to Box 398, FOUNDRY TRADE JOURNAL.

WANTED, for a Light Castings Foundry in the Devonshire area, a FOREMAN MOULDER; experienced in plate moulding; must be good disciplinarian; house provided.—Reply, giving particulars of technical knowledge,, experience, and age, to Box 400, FOUNDRY TRADE JOURNAL.

WANTED, London area, fully qualified DRAUGHTSMAN; preferably with metallurgical and foundry experience.—Box 444, FOUNDRY TRADE JOURNAL.

FOUNDRY MAN, with small Aluminium Foundry, would like to contact another Foundry Man that can furnish orders; consider partnership; confidentially; Midlands.—Box 430, FOUNDRY TRADE JOURNAL.

BUSINESS FOR SALE

MANCHESTER Engineering Firm, owning small modern Iron Foundry, used as auxiliary to their main supply of castings, wishes to dispose of same; guaranteed orders for castings at good prices, if required.—Box 434, FOUNDRY TRADE JOURNAL.

AGENCIES

AGENTS required, several areas, for binder of wide application; preferably technical, and capable demonstration.—Box 442, FOUNDRY TRADE JOURNAL.

FOUNDRY MECHANISATION EXPERT would be willing to recommend Moulding Machines, Moulding Plants of good make, to his clients, on commission basis, from well-established firms.—Box 366, FOUNDRY TRADE JOURNAL.